MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. LXXXVII. JANUARY 14, 1927. No. 3.

Sir FRANK W. DYSON, VICE-PRESIDENT, in the Chair.

Norman Knight Niness, 65 Douglas Road, Handsworth, Birmingham;

Thomas Whitwell, Government Actuary's Dept., Treasury Chambers, Whitehall, S.W. 1; and 42 Seymour Road, Hornsey, London, N. 8; and

Captain John Williams, Moorings, Aberdovey, N. Wales,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended:—

Ronald Allan, 204A High Holborn, London, W.C. 1 (proposed by A. Jobling);

Carlyle S. Beals, M.A., Ph.D., Assistant Professor of Physics, Acadia University, Wolfville, Nova Scotia, Canada (proposed by A. Fowler);

Henry Whitworth Davis, M.I.C.E., M.I.M.E., The Manor House, Earsdon, Northumberland (proposed by W. Hall);

Captain Thomas Leonard Gillett, Elmdon, Adelaide Grove, East Cowes, Isle of Wight (proposed by R. E. Beare);

Rudolf Kingslake, M.Sc., A.R.C.S., D.I.C., Beit Scientific Research Fellow, Imperial College of Science and Technology, S. Kensington; 171 Grove Lane, Camberwell, London, S.E. 5 (proposed by A. E. Conrady);

P. J. van Rhijn, Director of the Kapteyn Astronomical Laboratory, Groningen, Holland (proposed by J. Jackson);
Theodore Thomas Ambrose Varley, Feizor, Jersey Road, Heston, Middlesex (proposed by W. Doberck); and
Rev. Frederick James Wright, F.R.M.S., 332 Audley Range, Blackburn, Lancashire (proposed by C. B. Johnson).

Eighty-one presents were announced as having been received since the last meeting, including, amongst others :—

Astrographic Charts: Bordeaux Observatory, zones +12°, +14°, +16° (21 charts); Paris Observatory, zones +18°, +20°, +22° (25 charts); Toulouse Observatory, zones +5°, +9° (4 charts).
Berlin-Babelsberg, Universitäts-Sternwarte, Kleinere Veröffentlichungen, No. 1.
British Association Seismology Committee, 27th, 28th, 29th, and 30th Reports.
——————————— International Seismological Summary, 1922; 1923 January–June.
Johannesburg, Union Observatory, Southern Double Star Catalogue: R.A. 16^h–16^h $58^m.8$.
Macpherson (Hector): Modern Astronomy, its Rise and Progress.
An ivory portable String Compass Dial, by Hans Tröschel (1567–1612) (presented by Captain J. H. Jones, R.N.).

The Chairman announced that the Gold Medal of the Society had been awarded to Professor Frank Schlesinger, for his work on Stellar Parallax and Astronomical Photography.

Trepidation. (Second Paper.) By J. K. Fotheringham, D.Litt.

1. *Longitude of the Sun.*—In a note appended to my paper on Trepidation in the last number of *Monthly Notices* I mentioned that when the paper was in proof I had noticed that Dr. Brown,* from whom I had taken the observed longitudes of the Sun and Moon, had not applied the correction of $+^s.005$ necessary to reduce the Greenwich Right Ascensions in 1915 and subsequent years to the equinox of Newcomb's system N_1. This correction is required in order to remove the mean effect of the magnitude equation applied to the clock stars used at Greenwich.† I therefore applied a correction of $+^s.005 \cos \epsilon = +0''.07$ to the values of fm in my table of "Observed—Tabular

* *Transactions of the Astronomical Observatory of Yale University*, **3**, 219, 223, (1926).

† See the Introduction to the *First Greenwich Catalogue of Stars for* 1925·0, and Mr. Cullen's paper in *M.N.*, **85**, 1000–1006.

Longtiudes" for the Moon from 1915 onwards, and of + 0″·08 to the values of fs in the same table. The factor cos ϵ was introduced in the case of the Moon, because the lunar deviations had been determined from Right Ascensions and Declinations combined, while the solar deviation had been determined from Right Ascensions only. In Group 22, which included the four years 1913–16, only half this correction, + 0″·04 in each case, was applied.

With these corrections equation (3) in that paper assumes the form:

$$\Delta L' = -0''{\cdot}040 - 0''{\cdot}026T + 0''{\cdot}867T^2 + 0{\cdot}1051fm \quad . \quad (1)$$
$$\pm\ ''{\cdot}035 \pm\ ''{\cdot}12 \quad \pm\ ''{\cdot}15 \quad \pm\ {\cdot}0075$$

The residuals of the solution as revised are as follows (in no case are they changed by more than ±0″·03):—

No.	Date.	Res.	No.	Date.	Res.	No.	Date.	Res.
		″			″			″
1	1750–62	+0·06		1827–30	−0·83	14	1879–82	+0·52
2	65–71	+0·03		31–34	+0·71	15	83–88	+0·07
3	72–78	−0·20		35–38	+1·09	16	89–92	+0·03
	79–85	+1·84	4	39–42	+0·29	17	93–96	−0·09
	86–92	+0·44	5	43–46	−0·27	18	97–00	−0·32
	93–97	+0·92	6	47–50	−0·11	19	1901–04	−0·26
	98–02	+0·16	7	51–54	−0·04	20	05–08	−0·12
	1803–06	−0·45	8	55–58	−0·31	21	09–12	−0·03
	07–10	−1·13	9	59–62	−0·19	22	13–16	−0·02
	11–14	−3·92	10	63–66	+0·11	23	17–20	+0·16
	15–18	−2·15	11	67–70	+0·29	24	21–23	+0·07
	19–22	−1·28	12	71–74	+0·11	25	24–25	+0·07
	23–26	−1·98	13	75–78	+0·29			

The increase of the constant ratio from + 0·1025 to + 0·1051 affects the reduction of the Sun to mean place.

We now get

$$+ 0''{\cdot}72 + 2''{\cdot}45T + 0''{\cdot}49T^2$$
$$- 0''{\cdot}04 - 0''{\cdot}03T + 0''{\cdot}87T^2$$
$$= + 0''{\cdot}68 + 2''{\cdot}42T + 1''{\cdot}36T^2 \quad (1884{\cdot}5) \quad . \quad . \quad (2)$$

to which we may add + 0·1051ΔL, where ΔL represents any correction which it may be desired to apply to the adopted mean longitude of the Moon.

The correction to Newcomb's mean longitude as referred to the equinox of his system N_1 then becomes

$$\Delta L' = + 1''{\cdot}03 + 3''{\cdot}81T + 1''{\cdot}36T^2 \quad + 0{\cdot}1051\Delta L \quad (1884{\cdot}5) \quad (3)$$
$$= - 1''{\cdot}22 + 1''{\cdot}51T + 1''{\cdot}36T^2 \quad + 0{\cdot}1051\Delta L \quad (1800) \quad . \quad (4)$$
$$= + 1''{\cdot}65 + 4''{\cdot}23T + 1''{\cdot}36T^2 \quad + 0{\cdot}1051\Delta L \quad (1900) \quad . \quad (5)$$

With these revised figures the total observed fluctuation of the Sun differs from that tabulated in the first paper by an amount never exceeding ± 0″·07. The revised values are as follows :—

No.	Date.	Total Observed Fluctuation of Sun.	No.	Date.	Total Observed Fluctuation of Sun.	No.	Date.	Total Observed Fluctuation of Sun.
		″			″			″
1	1750–62	+0·99		1827–30	−0·11	14	1879–82	−0·55
2	65–71	+1·28		31–34	+1·21	15	83–88	−1·22
3	72–78	+1·15		35–38	+1·49	16	89–92	−1·44
	79–85	+3·39	4	39–42	+0·64	17	93–96	−1·71
	86–92	+2·05	5	43–46	+0·10	18	97–00	−1·96
	93–97	+2·41	6	47–50	+0·25	19	1901–04	−1·74
	98–02	+1·51	7	51–54	+0·33	20	05–08	−1·47
	1803–06	+0·74	8	55–58	0·00	21	09–12	−1·26
	07–10	+0·07	9	59–62	−0·03	22	13–16	−1·07
	11–14	−2·98	10	63–66	+0·14	23	17–20	−0·83
	15–18	−1·27	11	67–70	−0·02	24	21–23	−0·97
	19–22	−0·54	12	71–74	−0·55	25	24–25	−1·08
	23–26	−1·15	13	75–78	−0·66			

For the last four groups the total observed fluctuation of the Moon becomes :

No.	Date.	Total Observed Fluctuation of Moon.	No.	Date.	Total Observed Fluctuation of Moon.
		″			″
22	1913–16	−9·87	24	1921–23	− 9·79
23	17–20	−9·42	25	24–25	−10·99

Herr Schoch has recently published in Selbstverlag, Berlin-Steglitz, Kuhligkshof 5, a paper entitled *Die säkulare Acceleration des Mondes und der Sonne*. From a careful examination of ancient occultations and eclipses and of the solar eclipses of + 1239 June 3 and + 1715 May 3, he arrives at corrected values for the elements of the motion of the Sun and Moon. The two terms which can best be determined from eclipses are D and F–D, where D is the excess of the Moon's over the Sun's mean longitude and F is the Moon's mean argument of latitude. Postponing the discussion of F–D till I have had an opportunity of examining the effect of trepidation on the motion of the Moon's node, I note that Herr Schoch's expression for the longitude of the Moon is

$$L = 335^\circ\ 43'\ 24''\cdot37 + 1732564394''\cdot50T + 12''\cdot20T^2 + 0''\cdot0066T^3 \qquad (6)$$

where T is the number of Julian centuries elapsed since 1800 Jan. 0, Greenwich Mean Noon.

I have adopted in the present discussion,

$$L = 335^\circ\ 43'\ 25''\cdot19 + 1732564393''\cdot82T + 11''\cdot91T^2 + 0''\cdot0068T^3 \quad (7)$$

so that, if both expressions are applied to the same equinox, the difference, Schoch–Fotheringham, amounts to

$$\Delta L = -0''\cdot82 + 0''\cdot68T + 0''\cdot29T^2 - 0''\cdot0002T^3 \quad . \quad (8)$$

For the Sun's longitude referred to the same epoch, Herr Schoch has obtained the value :

$$L' = 279^\circ\ 54'\ 49''\cdot60 + 129602764''\cdot37T + 2''\cdot60T^2 \quad . \quad (9)$$

I have just found :

$$L' = 279^\circ\ 54'\ 48''\cdot11 + 129602767''\cdot46T + 2''\cdot45T^2 \quad . \quad (10)$$

The difference, Schoch – Fotheringham, is

$$+1''\cdot49 - 3''\cdot09T + 0''\cdot15T^2 \quad . \quad . \quad . \quad (11)$$

Herr Schoch's value for D, therefore, exceeds mine by

$$-2''\cdot31 + 3''\cdot77T + 0''\cdot14T^2 - 0''\cdot0002T^3 \quad . \quad . \quad (12)$$

The difference between our expressions for D has the following values at different epochs :—

Epoch.	Schoch–Fotheringham.	Epoch.	Schoch–Fotheringham.
−1000	+ 6″·28	+ 500	−27″·22
− 500	−12·53	+1000	−23·41
0	−23·65	+1500	−12·35

In regard to the Babylonian eclipse of − 424 October 9, briefly discussed by Herr Schoch in his paper, it should be noted that the Babylonians frequently record the interval between sunset and moonrise or between moonset and sunrise. Herr Schoch informs me that he has verified many of these intervals by computation, and finds that they show no systematic error and that the actual error seldom exceeds 2 *UŠ* or eight minutes. There is, therefore, no room for a large correction to the value of D adopted by Herr Schoch, which places the beginning of this eclipse 47 minutes, as compared with the observed 10 *UŠ* (= 40 minutes), after sunset.

2. *The Mass of Venus.*—In my former paper on Trepidation I assigned to each determination of the mass of Venus a weight proportional to the square of the number of years on which the determination was based. I have since decided that it would be more reasonable to make the weight proportional to the number of years. At the same time, I have revised the figures which I derived from the Cape heliometer observations of Mars. The observations of Mars are subject to the disadvantage, as compared with the observations of the Sun, that they are generally made only in the immediate neighbourhood of opposition

and, therefore, weight themselves automatically according to the phase of the Venus inequality at the time of opposition. Therefore, if the annual increase in the Moon's fluctuation varies appreciably in the interval under discussion, the mean annual increase used in this discussion may not be the same as the mean annual increase, automatically weighted by the different phases of the inequality. The difference is increased when the investigator has further weighted the observations at different oppositions according to their precision. In order to include the actual rate of change of fluctuation at each opposition I have included in my computation the whole interval from the beginning of the year when the first observation of each series was made to the end of the year when the last was made. I find that on this principle the two Cape series should have had annual increases of + 0″·26 and + 0″·17 instead of + 0″·23 and + 0″·14 assigned to them. I also observe that Hough made two determinations from the series of observations from 1899 to 1920, in one of which the observations at each opposition were weighted according to precision, while in the other each opposition was assigned equal weight. Hough gave the preference to the former solution, which I adopted in my discussion, but in view of the effect of changes in the annual increase in the Moon's fluctuation, it is now clear to me that I ought to have adopted the alternative solution. This gives − 0·0120 ± 0·0063 instead of − 0·0309 ± 0·0071 as the correction to Newcomb's mass of Venus. Reduced to the form of a correction to Le Verrier's provisional mass, the former becomes − 0·027 as against − 0·046. The reason for the difference is apparent from the weights assigned by Hough in the solution which I formerly adopted. These were :

Opposition.	Weight.	Opposition.	Weight.
1899	49	1911	144
1901	121	1914	100
1903	36	1916	100
1905	169	1918	64
1907	169	1920	7
1909	289		

Now the annual increase in the Moon's fluctuation is very uniform throughout this series till 1917, after which it diminishes rapidly. But the effect of Hough's weights is to reduce to a minimum the effect of the observations after this diminution begins. His adopted correction to the mass of Venus corresponds, therefore, not to the mean slope of the trepidation curve from 1899 to 1920, with which I compared it, but with the far steeper mean slope between 1899 and 1917. If, therefore, the mean slope is to be computed for the years 1899–1920, it is better to use the determination in which equal weight is assigned to each opposition.

Dr. Jones continued Hough's series, as I stated, to 1924. He retained Hough's weights except for 1920, to which he assigned weight 49 instead of 7, and assigned weights 144 and 1156 to the oppositions of 1922 and 1924 respectively. I was wrong in asserting that he

attached special weight to the opposition of 1920. It is clear that the introduction of these additional observations, taken from the downward slope of the curve, especially in view of the great weight attached to 1924, was bound to have a marked effect on Hough's weighted result, and, as has been seen, it raised the observed correction to Le Verrier's mass of Venus from − ·046 to − ·026, in close agreement with Hough's result of − ·027 from the solution in which each opposition received equal weight. It is probable that the Greenwich meridian observations of Mars from 1899 to 1920 gave a smaller mass than that given by Hough's unweighted solution, for Dr. Jones states that they gave a smaller weight than his own solution, which differs little from it.

Though it is clear that the Cape results could stand a little manipulation, I have thought it best in the present solution to use Hough's unweighted and Dr. Jones's weighted mean solutions, attaching half-weight to the latter, but correcting the mean annual increase in fluctuation as above. Backlund's determination from Encke's comet also receives half-weight as before. Otherwise the weighting is in accordance with the number of years covered by the observations.

I thus get the following revised table of equations and residuals to take the place of the table given in my former paper:—

Weight.	Date.	*a*.	*b*.		Res.
29	1750–78	1	+0·21	= −·029	+·001
20	1819–58	1	−0·14	−·025	−·014
24	1843–66	1	−0·20	−·021	−·014
29	1847–75	1	−0·41	+·016	+·012
37	1864–1900	1	−0·42	+·007	+·002
26	1867–92	1	−0·52	+·006	−·004
36	1877–1912	1	−0·05	−·016	−·0005
22	1899–1920	1	+0·26	−·027	+·005
13	1899–1924	1	+0·17	−·026	+·0015
88	1836–1923	1	−0·17	−·007	+·002

Of the eight determinations to which probable errors were assigned, 1843–66 and 1847–75 leave residuals amounting to two or three times the probable error, 1836–1923 leaves a residual approximately equal to the probable error. The other five are within the probable error. Of the two to which probable errors were not assigned, one gave a small and the other a large residual. The agreement is, therefore, in good agreement with expectation. It may be observed that the three determinations which give large residuals all belong to the middle of the nineteenth century. It is possible, therefore, that there may be a real discordance here, which awaits its solution. But the discordance is not sufficient to affect the general conclusion that the observed mass of Venus is subject to a fluctuation which varies inversely with the annual increase in the Moon's fluctuation.

The numerical result may be expressed as follows:—

$$\text{Mass of Venus} = \text{Le Verrier's Mass} - 0{\cdot}0182 \pm {\cdot}0019 - (0{\cdot}0546 \pm {\cdot}0068)\phi \qquad (13)$$

where ϕ is the annual increase in seconds in the Moon's fluctuation. Referred to the mass of the Sun, this becomes

$$\text{Mean Mass} = \frac{1 - (0{\cdot}0556 \pm {\cdot}0069)\phi}{409300 \pm 790} \quad . \quad . \quad (14)$$

In this solution the mean motion and acceleration of the Moon were assumed from my determination made in 1920. The actual mean motion does not, however, enter into the problem. What we are concerned to know is what motion of the Moon corresponds to a particular mass of Venus. Now the observations discussed are spread over 175 years in which the annual mean motion of the Moon has increased by about $0''{\cdot}38$ owing to secular acceleration. But it is clear that this increase has no relation to the mass of Venus, for our study has shown us that the same annual change of fluctuation in the mass of Venus corresponds to a given annual increase in the fluctuation in the time of Bradley as in the time of Jones, in spite of the increase of $0''{\cdot}30$ in the annual mean motion between their several epochs. It might, therefore, seem possible from the separate determinations of the mass of Venus to form equations to distinguish between so much of the changes in the Moon's motion as is due to secular acceleration and so much as is due to trepidation. It has never been found possible to do this from the modern observations of the Moon alone.

I have, therefore, analysed the motion of the Moon on the assumption that the changes in its rate of motion, apart from periodic terms deduced from gravitational theory, consist of (1) a fluctuation bearing a constant ratio to the fluctuation in the reciprocal of the mass of Venus, and (2) a secular acceleration. I use the reciprocal of the mass rather than the actual mass, because it seems intrinsically more probable that the Sun's mass fluctuates than that the mass of Venus itself fluctuates,* and, since the mass of Venus is expressed in terms of the Sun's mass, a fluctuation in the Sun's mass will appear as a fluctuation in the reciprocal of the mass of Venus. But, since the largest fluctuation of mass under investigation does not exceed 3·4 per cent. of the mean mass, it is of small importance whether we regard it as a fluctuation of the mass of Venus or of its reciprocal.

The equations of condition now take the form

$$\alpha + \beta\zeta + \gamma T/50 = n,$$

where α is the correction to be applied to the annual motion corresponding to the assumed value of the mean mass; β is the increment in the annual motion of the Moon corresponding to an increment of 1 in the reciprocal of the mass of Venus, the mean mass being represented by unity; ζ is the observed excess of the reciprocal of the mass over its mean value, the mean mass being represented by unity; γ is the correction to be applied to the adopted value of the coefficient

* It is, perhaps, still more probable that the masses of both bodies fluctuate, but that the mass of Venus fluctuates more than the mass of the Sun in proportion to their respective total amounts. If so, I was not justified in using the reciprocal.—1927 *January* 25.

of T^2 in the expression for the longitude of the Moon, where T is reckoned in centuries from 1869; and n is the observed annual excess of the Moon's motion over her motion computed with the adopted values for mean motion and secular acceleration.

The assumed value of the mean mass of Venus is that which has just been determined.

Making the necessary transformations in the equations of condition given above, and using the same weights, but computing each term to a further decimal place, I find

$$\alpha = -0''\cdot034 \pm 0''\cdot032, \quad \beta = +14''\cdot42 \pm 1''\cdot98, \quad \gamma = +1''\cdot42 \pm 3''\cdot81.$$

Since the adopted value of the sidereal secular acceleration of the Moon is $+10''\cdot80$ at epoch 1800, this gives for the acceleration at that epoch, expressed in the usual way, a value of $+12''\cdot22 \pm 3''\cdot81$. In view of the large probable error, this value does not help us to determine the acceleration. It only shows that the fluctuation in the mass of Venus gives an indication in the right direction. It will be noticed that the value thus obtained for β is affected by a probable error larger in proportion than that which attaches to its reciprocal as determined above, where an acceleration of $+10''\cdot80$ was assumed on the evidence of ancient observations.

Introducing the value $+12''\cdot22 \pm 3''\cdot81$ for the lunar acceleration into the discussion of the solar acceleration, we have for the solar acceleration,

$$\left.\begin{aligned} &+1''\cdot34 + 1''\cdot42 \times 0\cdot1051 = +1''\cdot34 + 0''\cdot15 \\ &\pm\ ''\cdot15 \pm 3''\cdot81 \pm\ \cdot0075 \quad \pm\ ''\cdot15 \pm\ ''\cdot40 \\ &= +1''\cdot49 \pm\ ''\cdot43. \end{aligned}\right\} \quad . \quad . \quad (15)$$

But for the more exact value deduced above on the assumption that the value of the lunar acceleration derived from ancient observations is correct, this would have been regarded as a valuable determination, and I believe that for both accelerations the values given here are the only values that have been determined from modern observations alone. For neither term has any observation older than 1750 been employed.

3. *The Equinox.*—In my former paper I gave an expression, obtained by trial and error, for the position and motion of the equinox, and in a note I gave the result of a least-squares solution. For this least-squares solution I decided to use the values cited from the *First Greenwich Catalogue of Stars for* 1925·0 for the position of the equinox at epochs 1851, 1857, 1864, 1872, 1882, and 1891, and to use the values cited from Mr. Cullen's paper * for his five groups from 1897 to 1924. In both series the value given is the amount by which the Sun's longitude referred to the equinox of Newcomb's system N_1, as determined from the Sun's Right Ascensions observed at Greenwich, differs from its longitude as determined from declinations observed at Greenwich. The values thus obtained are necessarily affected by the observational errors in both co-ordinates.

* *M.N.*, **85** (1925), 1000–1006.

The figures given by Mr. Cullen * seem to show that from 1897 to 1924 the mean correction for latitude variation has exceeded the mean error in Right Ascension as determined by me in this discussion, and I concluded that it would be best to attach preponderant weight to the observations from 1897 onwards, which have been reduced with corrections for latitude variation. I therefore attached weight 1 to each of the six Greenwich determinations from observations older than 1897, while each of Mr. Cullen's groups from 1897 onwards received a weight equal to the number of years which it contained. In this way the combined weight of the observations from 1897 to 1924 came to 28, while the combined weight of the older observations was taken as 6. An independent solution was also made in which each of the six determinations and each of Mr. Cullen's groups received equal weight, so that the preponderance of the later observations was greatly reduced. In the second solution the Moon's place was not reduced from the equinox used at Greenwich from 1915 onwards to the equinox of Newcomb's system N_1, but the difference made by this reduction is unimportant.

The first solution gave as the reduction from Newcomb's equinox to the true equinox of date,

$$\Delta RA = -1''\cdot17 - 2''\cdot29T - 0\cdot0643m \quad (1900\cdot0) \quad . \quad (16)$$
$$\pm\ ''\cdot090 \pm\ ''\cdot21 \pm\ \cdot0085$$

where m is the total fluctuation of the Moon at date.

The second solution gave

$$\Delta RA = -1''\cdot06 - 2''\cdot00T - 0\cdot0508m \quad . \quad . \quad (17)$$
$$\pm\ ''\cdot12 \pm\ ''\cdot30 \pm\ \cdot0110$$

The following table gives the result of the analysis on the first solution, and the residuals of both solutions. a is the observed equinox correction as given in the Greenwich Catalogue or by Mr. Cullen; b is the constant $+ 1''\cdot17$; c is $+ 2''\cdot29T$; and d is $+ 0\cdot0643m$.

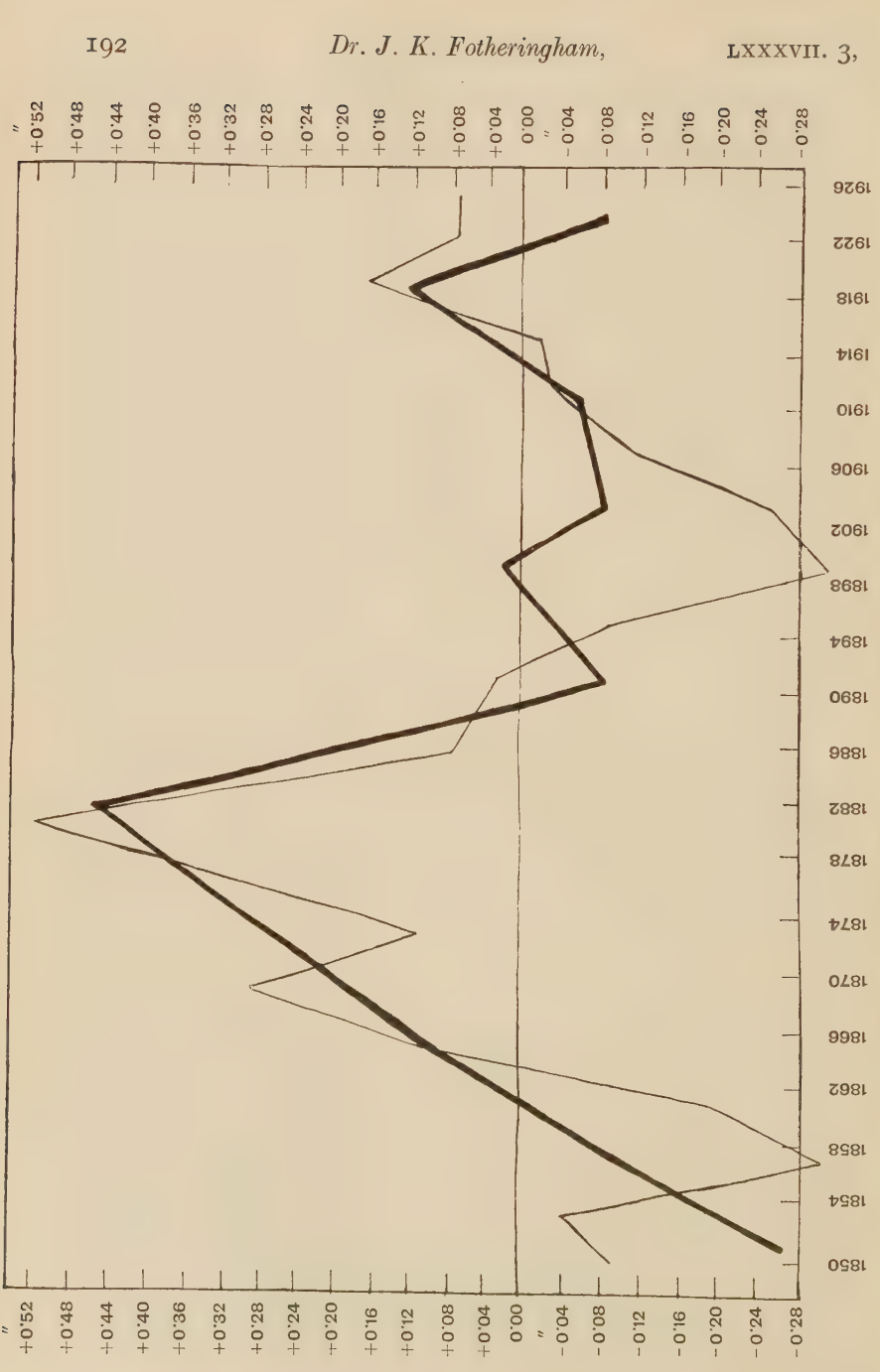
Date.	*a.*	*b.*	*c.*	*d.*	Res. (1).	Res. (2).
	″	″	″	″	″	″
1851	0·00	+1·17	−1·12	+0·22	+0·27	+0·26
1857	−0·29	+1·17	−0·98	+0·18	+0·08	+0·05
1864	−0·48	+1·17	−0·82	+0·04	−0·09	−0·11
1872	−0·44	+1·17	−0·64	−0·34	−0·25	−0·21
1882	−0·53	+1·17	−0·41	−0·68	−0·45	−0·36
1891	+0·03	+1·17	−0·21	−0·89	+0·09	+0·20
1897–1900	−0·18	+1·17	−0·02	−0·99	−0·02	+0·08
1901–05	−0·26	+1·17	+0·08	−0·90	+0·09	+0·16
1906–14	−0·60	+1·17	+0·24	−0·75	+0·06	+0·08
1915–21	−1·10	+1·17	+0·42	−0·61	−0·12	−0·15
1922–24	−0·96	+1·17	+0·54	−0·66	+0·09	+0·05

* *Loc. cit.*, p. 1004.

It will be seen that while the first solution, as compared with the second, gives residuals barely larger in the mean for the first six groups, it gives markedly smaller residuals for the five concluding groups. Even on the second solution the residuals of these groups are in the mean only half as large as those of the first six groups, so that it would be justifiable to attach to each of the concluding groups weight 4, while the difference in the size of the residuals given by the first solution would justify even larger weights than have been assigned. But, while the least-squares solution aimed only at reducing the residuals to a minimum, the true test of a correct solution is that it reduces the residuals to a minimum where the observed Right Ascension is correct and reproduces the error of the Right Ascension with sign reversed, where the Right Ascension is in error. As the Right Ascensions have been analysed in different groups, this test can be best applied with the aid of a diagram. Diagrams were in consequence drawn to test both solutions. The second solution appeared to make a compromise wherever the observed Right Ascension differed from that computed in this paper, but the first solution was unexpectedly successful in showing an almost exact agreement between the residuals in equinox correction with sign reversed and the residuals in Right Ascension, wherever the latter appeared to be due to observational error, and in keeping the residuals in equinox correction near the zero line where this was not the case. In fact, the comparison between the two graphs on the diagram appended to this paper shows a surprising accuracy in the Greenwich declinations throughout the whole interval from 1851 to 1924. In this diagram the heavy line represents the residuals in the position of the equinox with sign reversed, resulting from the first solution, while the light line represents the residuals in the Sun's longitude determined from the Greenwich Right Ascensions, as found in the earlier part of this paper. My expression for the correction to Newcomb's longitude referred to true equinox is to be obtained by adding formulæ (5) and (16) of this paper, first substituting $+ 0{\cdot}1051m$ for $+ 0{\cdot}1051\Delta L$ in the first of these formulæ. I thus obtain

$$\Delta L' = + 0''{\cdot}48 + 1''{\cdot}94T + 1''{\cdot}36T^2 + 0{\cdot}0408m \quad (1900) \quad . \quad . \quad (18)$$

The excess of the longitude obtained from the Greenwich observations of declination over the longitude expressed by this formula is represented in the diagram by the distance by which the thin line stands above the thick line. When allowance is made for the difference in grouping the observations of different years, the groups used for Right Ascensions being smaller than those used for the equinox, it will be observed that the deviation of my formula from the observed declination rarely exceeds $\pm 0''{\cdot}10$ and is in general considerably less. Thus from about 1850 to about 1890 the equinox graph is in close agreement with the Right Ascension graph, which means that the Declinations agree with my formula, so that the deviation of the observed Right Ascensions may be regarded as resulting wholly from observational errors. It will be observed that this error after rising to $+ 0''{\cdot}50$ (O − T) comes to an abrupt end about or shortly after 1882. After a few years of good agreement between the formula and both series of



Heavy line represents Residuals in position of the Equinox with sign reversed.
Light " " " Sun's Right Ascension.

observations, the Right Ascensions show a negative trend, reaching − 0″·32 about 1899. The agreement between the Right Ascensions and Declinations is proved by the close adhesion of the heavy line on the diagram to the zero line. We must, therefore, regard this discordance as real. It may possibly be an indirect effect of trepidation, or it may be due to some unexplained cause. It is to be noted that it occurs at a bend of the trepidation curve, which appears to take a sharper turn at this point in the Sun's longitude than in the Moon's. The close agreement of the two graphs from 1910 or earlier to 1919 or later shows that the rapid increase in the observed Right Ascension between those dates is due to observational error and is not borne out by the declinations.

The graphs seem to show that the change of personality in or about 1915 produced a temporary increase of about 0″·20 in the observed Right Ascension. The *First Greenwich Catalogue for* 1925·0 shows that in the years 1915–21, in spite of the introduction of the travelling micrometer wire, the extreme range of personal equations between different observers for an annual mean still exceeds 0″·6, and for a seven-years' mean amounts to about 0″·5. It also shows that there has been great difference in different years in the distribution of the observations among different observers, and that it is of frequent occurrence for an observer at either end of the range of personality to have the largest share in the observations. Since these observations are not reduced to a common standard, it is not surprising that there should still be fluctuations of the order of ± 0″·10 in the residuals given by four-year group means. But there appears to me to be no evidence of a discontinuity between the whole series of observations ending in 1914 and those beginning in 1915.

The graphs do not anywhere disclose any appreciable error in the Greenwich declinations unless it be in the final Group 1921–23, which contains three years only. Here the declinations appear to give a longitude about + 0″·16 in excess of my formula, while the Right Ascensions give an excess of + 0″·07 only.

There is also no trace of any error in the theoretical inequalities in the Moon's motion. An error in an inequality of sufficiently long period to affect the mean of a group of four or more years would be included by my computation in the Moon's fluctuation, and would in consequence displace the heavy line on the diagram by 0·1051 of itself and the light line by 0·0643 of itself. There is no trace of any displacement of this magnitude.

The diagram also enables us to judge how far the values found in this paper are capable of emendation. It seems clear that a better agreement between the heavy line and the zero line, where we have no reason to suspect observational error in Right Ascension, and between the heavy line and the light line, where such error is manifest, would be obtained by raising the whole heavy line by about + 0″·04, which would involve a constant correction of − 0″·04 to my formula for the position of the equinox. The heavy line, it is true, stands + 0″·07 higher at epoch 1881 than the light line, but since the groups meaned for the equinox are about twice as long as those meaned for the Right

Ascensions, the heavy line should naturally avoid the extreme deviations shown by the light line. But, if we are to apply the correction of − 0″·04 to the equinox, it becomes impossible to apply any correction to the mean longitude as referred to Newcomb's equinox. To move the thin line downwards would counteract the agreement gained by moving the heavy line upwards. To move the thin line upwards would increase the existing discrepancy between observation and computation and would necessitate a corresponding shift of the heavy line, which would raise its mean position above the mean of the apparently good determinations of 1890 to 1910 or thereabouts. Apart, therefore, from any correction required to compensate a correction to the mean longitude of the Moon, it would appear that the equinox derived in this paper requires a correction of approximately − 0″·04, but that no correction to mean longitude referred to Newcomb's equinox is admissible. Any correction to the assumed mean longitude of the Moon at the present day is not likely to be greatly in excess of ± 0″·50, so that any resulting correction to the mean longitude of the Sun is not likely to exceed ± 0″·05, and any such correction to the equinox should not exceed ∓ 0″·03.

Applying the final correction of − 0″·04 to the equinox of formulæ (16) and (18), I get as a final value for the reduction from Newcomb's equinox to true equinox,

$$\Delta RA = -1''\cdot21 - 2''\cdot29T - 0\cdot0643m \quad (1900) \quad . \quad (19)$$

and as a final value for the correction to Newcomb's longitude of the Sun referred to mean equinox

$$\Delta L' = +0''\cdot44 + 1''\cdot94T + 1''\cdot36T^2 \quad (1900) \; . \quad . \quad (20)$$

It must be remembered that Newcomb's determination of the mean longitude of the Sun was made from declinations only and referred to true equinox and not to the equinox of his system N_1. To compare my formula with his, it appears to be best to reduce it to his epoch 1850. I then get

$$\Delta L' = -0''\cdot19 + 0''\cdot58T + 1''\cdot36T^2 \quad (1850) \; . \quad . \quad (21)$$

a far less striking difference than those found for other epochs or other equinoxes.

Incidentally the diagram shows that I was in error in my former paper in suggesting that the negative trend in the equinox correction between 1851 and 1864, as shown by the Greenwich meridian observations, was connected with the minor fluctuation. It is mainly the result of systematic errors in the Greenwich Right Ascensions.

If we compare the new formula for the equinox with the observed positions derived by Newcomb from the occultations,* we shall find that with one exception all his nineteenth-century values are satisfied within their probable errors, but that the new formula requires a negative correction if it is to satisfy his eighteenth-century values.

* *Researches on the Motion of the Moon,* pt. ii., pp. 212–222.

The following table exhibits the differences:—

Date.	Observed.	Computed.	Date.	Observed.	Computed.
	″	″		″	″
1720	+0·15	About +2·9	1848	−0·03	−0·24
1761	−4·05	−1·33	1865	+0·15	−0·43
1792	−1·02	+0·29	1882	−0·30	−0·12
1811	+0·06	+0·17	1899	−0·18	−0·24
1829	+0·12	−0·03			

The only discordance in the nineteenth century, at epoch 1865, does not tell against the formula, which is well supported by the meridian observations of that date. With the eighteenth century occultations we may compare Bradley's meridian observations. Newcomb, in his *Astronomical Constants*, divided Bradley's solar declinations into two groups with central epochs 1755·5 and 1760·5 respectively. By comparison of his Right Ascensions and Declinations I get for the observed correction to the equinox of Newcomb's system N_1 at those dates + 0″·45 and + 1″·16 respectively. My formula gives + 1″·45 and + 1″·35 respectively. In the latter case the agreement is within the probable error; in the former it is not. Although Bradley's observations appear to be in serious discord with one another, and still more so with the occultations as reduced by Newcomb, it is significant that all these values lie on the same side of the computed values. The excellent agreement of the Greenwich meridian observations since 1851 with my formula seems to exclude any correction which would seriously affect those years, and the question therefore arises whether th ›en-tennial term in the formula is subject to some variation.

It will be noticed that the empirical secular acceleration of the Sun's mean motion deduced in this paper (+ 1″·36) greatly exceeds the maximum (+ 0″·9) which Dr. Jeffreys * regards as explicable by tidal friction. In view of the evidence contained in this discussion for variation of mass within the solar system it seems reasonable to suppose with Professor Newall † that a part of the acceleration may be due to a secular increase in the Sun's mass. Now it has just been found that a fluctuation in the Sun's longitude in sympathy with a variation in the mass of Venus is accompanied by a fluctuation − 0·612 times as large in the position of the equinox. If the same ratio applies to the secular accelerations so far as they are the result of a variation of mass within the solar system, there ought to be a negative acceleration in the motion of the equinox which will be of the right order to bring Bradley's observations into good agreement with the formula deduced in this paper from more recent observations. It ought to be possible to determine this term by treating the Greenwich Declinations in the same way in which the Greenwich Right Ascensions have been treated in this discussion, but in view of the large discordances which Newcomb found in the Declinations from 1753 to 1797, the investigation may be expected to yield a rather weak result.

* *The Earth* (1924), pp. 215, 216. † *M.N.*, **69**, 339–341 (1909).

4. *Some Possible Examples of Trepidation.*—In 1925 Dr. Jones * discussed the Cape heliometer observations of Mars. These, as has been seen, had been discussed by Hough from 1899 to 1920, while Dr. Jones continued the series to 1924. The interest of these observations lies in the fact that Hough's series almost exactly covers a slope of the trepidation curve quite different from anything that had previously existed in the nineteenth century, and it is therefore important to see what elements show values during this interval different from those which had been determined on the contrary slope. Hough found discrepancies between his values and those determined by Dr. Ross over the interval 1751 to 1912, far exceeding their probable errors, in the mean longitude, in the longitudes of perihelion and node, and in the inclination, but found agreement in the eccentricity. Dr. Jones continuing the series to 1924, and thus carrying it into a different slope of the trepidation curve, confirmed the discordances, but in the main reduced their amount. This is exactly what we should expect if the mean motion and the motion of the perihelion and node were affected by trepidation. We seem, therefore, to be invited to look for evidence of trepidation in the mean motions and motions of perihelia and nodes, and in the inclinations of the planets and satellites, including the motion of our equinox and the obliquity of the ecliptic.

University Observatory, Oxford :
1927 *January* 11.

On the Relation of Colour and Apparent Magnitude in some Regions of Low Galactic Latitude. By Dr. E. A. Kreiken.

(*Communicated by the Secretaries.*)

1. In the contributions of the Mount Wilson Observatory, No. 287, F. Seares derives the formula $I_c = -\cdot16-\cdot050m_{ph}$, which gives the mean colour of the stars of each apparent magnitude. This formula gives a mean for the whole sky. In this same paper Seares shows that the colour indices of the faint Milky-Way stars, which were derived by myself, are systematically smaller than would be expected from his formula. This is ascribed to the fact that all regions investigated by myself have very low galactic latitude.

In the present paper I give a detailed discussion of the colour-magnitude relation in a few totally different regions of the Milky Way. It appears that there are large differences between the separate regions, which cannot be ascribed either to systematic or to accidental errors. In view of the scantiness and the heterogenous nature of the material, I have not tried to give any general conclusions.

* *M.N.*, **85**, 853–858.

2. *The Material.*—The material was taken from the following sources :—

(*a*) E. Hertzsprung, "Effective Wave-Lengths of Stars in the Pleiades," *Mémoires de l'Acad. Royale des Sc. et des Lettres de Danemark*, tome iv., N. 4. Hertzsprung gives the colour indices of 1246 stars, which were determined according to the method of the effective wave-lengths. In the present paper all colour indices, determined in that way, are indicated by I_λ. Hertzsprung's list is probably complete down to $m = 14{\cdot}9$.

In the *Bulletin of the Astronomical Institutes of the Netherlands*, vol. **2**, No. 49, I have given a list of stars which probably belong to the Pleiades group and which is correct down to the same limit. With the help of this list we are able to discriminate between cluster and non-cluster stars in Hertzsprung's Catalogue.

(*b*) E. A. Kreiken, "On the Colour of the Faint Stars in the Milky Way and the Distance of the Scutum Group," *Inaugural Dissertation*, Groningen, 1922. In this work the I_λ of about 5000 stars are given. The colour system on which the values I_λ in my work are based is the same as that used by Hertzsprung, viz. the Göttingen Aktinometrie. Also the whole method of reduction is similar to that of Hertzsprung. So his colour indices and mine are directly comparable. The zero point of the magnitude scale was determined by comparison with the nearest region of the selected areas. In this comparison stars of about the 10th magnitude were used. A correction of $+ 0{\cdot}4m$ is necessary for reduction to the international scale.

(*c*) J. Harald Peterson, "Effective Wave-Lengths of Faint Stars in the Milky Way in Aquila," *Arkiv für Matematic. Astr. och Fys.*, Band 19, A, No. 3, 1925. Peterson discusses the colour-magnitude distribution of about 1020 stars in Aquila. (The centre of his region was R.A. $19^h\ 22^m$; Decl. 11° 30′.) The colour indices were determined according to the method of effective wave-lengths and are expressed in $\mu\mu$. On p. 11 (table 1) of his paper, Peterson gives the relation of effective wave-lengths to the spectral type according to the Henry Draper Catalogue. The relation of the colour indices of the Göttingen Aktinometrie to the H.D. was determined by K. Schwarzschild (*Gött. Akt.*, Teil B, p. 17). With the help of these two tables, it is easy to pass from Peterson's colour system to that used by myself.

(*d*) H. Shapley, "Colour Indices of Stars in the Galactic Clouds," *Ap. J.*, **45**, p. 64 and following. Shapley gives the colour indices of 313 stars in the dense galactic clouds near Messier 11. The colour indices I_c were derived by comparing their photographic and photovisual magnitudes.

The centres of all regions quoted above are given in Table I. of this paper.

TABLE I.

The Different Colour Regions.

Region.	Authority.	R.A.	Decl.	Gal. Lat.	Gal. Long.
		h m	° ′	°	°
Pleiades	E. Hertzsprung	3 42	+23 50		
Aquila	Peterson	19 22	+11 30	356	+14
I.	Kreiken	18 29	−10 38	351	− 5
II.	„	18 40	− 6 35	356	− 2
III. Scutum	„	18 48	− 2 57	2·5	− 4
IV.	„	21 38	+57 42	66	+ 3
V.	„	21 55	+58 16	71	+ 6
VI.	„	22 04	+58 51	71·2	+ 6·4
VII. (N.G.C. 6960)	„	20 42	+30 24	41	− 7
VIII. (Lyra)	„	18 50	+32 55	27	+14
Near M. 11 1	Shapley	..	..	357	− 5
2	„	..	..		
3	„	..	..		
4	„	..	..		

3. *Colour-Magnitude Curve in Scutum and Aquila.*—For various reasons I have combined the colour indices obtained by Peterson in the rich part of Aquila with my own in Scutum. Firstly, the two star-clouds appear to have exactly the same distance, viz. 1500 parsecs; secondly, the relation of colour index to apparent magnitude is exactly the same. This appears from Table II. The resulting weighted mean values of colour index are also given in this table; they were obtained by giving Peterson's values and my own weights, which are proportional to the number of stars on which they are based. These numbers are given in parentheses.

The final mean * values of the colour index were represented by a linear formula,

$$I_\lambda = A + Bm_{ph}.$$

From our data in Table II., I find by a least-square solution $A = -1{\cdot}120$; $B = +0{\cdot}1051$. So

$$I_\lambda = -1{\cdot}120 + 0{\cdot}1051 m_{ph},$$

the values of the mean colour computed with this formula and the differences Obs.-Comp. are inserted in Table II. It appears that the differences are small, except for the brightest stars, for which the

* The mean values were chosen in such a way that half the colour indices are larger, the other half smaller.

difference may be entirely accidental. It is, however, doubtful whether the linear formula in this region will also hold for a large range of magnitude. There is a small, but probably real, increase of the colour-gradient with magnitude. This appears more clearly from fig. 1, in which I have plotted the different values of I_λ against magnitude.

TABLE II.

Mean Colour in Scutum and Aquila.

m.	7·3	8·3.	9·3.	10·3.	11·3.	12·3.	13·3.	14·3.	15·3.
Scutum		..	+·70	+·35	+·05	+·10	+·20	+·30	+·53
			(2)	(3)	(20)	(36)	(101)	(480)	(604)
Aquila		..	..	−·10	+·09	+·09	+·21		
Rich region		..	..	(24)	(68)	(219)	(487)		
Mean		..	+·70	−·05	+·08	+·09	+·21	+·30	+·53
			(2)	(27)	(88)	(255)	(588)	(480)	(604)
I_λ comp.		..	..	−·07	+·04	+·14	+·24	+·34	+·44
O.–C.		..	..	+·02	+·04	−·05	−·03	−·04	+·09
Shapley		..	..	..	..	..	+·85	+·70	+·59
							(44)	(76)	(192)

The four regions investigated by Shapley are situated very near the area investigated by me. There is, however, a great difference between Shapley's mean values of colour and mine (see Table II.). First, Shapley found a decrease of mean colour with increasing magnitude, while I find an increase; secondly, Shapley's values are all much larger than mine. The difference is such, that it seems improbable that it is only due to a systematic difference between the colour systems used. We must admit the possibility that there are large differences between the colour-magnitude distribution in closely adjacent regions.

4. *Colour-Magnitude Curve in Cepheus.*—The three regions Kr. IV., V., and VI. are situated close together in Cepheus. Table III. shows the mean values of the colour for different magnitudes in the three regions. The differences are so small that we have combined them into one set. The weighted mean values are obtained in the same way as before. They may be represented by the formula

$$I_\lambda = -\cdot587 + 0\cdot0678 m_{ph},$$

which was found by a least-square solution.

The computed values of colour index and the differences Obs.-Comp. also appear in Table III.

TABLE III.

Mean Colour in Cepheus.

Region \ *m*.	7·3.	8·3.	9·3.	10·3.	11·3.	12·3.	13·3.	14·3.	15·3.
Kr. IV.	..	+·20	+·35	+·40	+·28	+·40	+·51	+·60	
		(4)	(7)	(8)	(17)	(21)	(54)	(68)	
Kr. V.	..	−·20	+·35	+·20	+·35	+·52	+·50	+·62	
		(2)	(1)	(6)	(6)	(14)	(26)	(36)	
Kr. VI.	0·00	..	+·54	+·75	+·25	+·40	+·40	+·55	
	(2)		(3)	(5)	(13)	(20)	(59)	(56)	
Mean	0·00	+·17	+·11	+·33	+·28	+·43	+·46	+·59	
	(2)	(6)	(11)	(19)	(36)	(55)	(139)	(160)	
Iλ comp.	+0·03	+·10	+·18	+·26	+·33	+·41	+·49	+·57	
O.–C.	−0·03	+·07	−·07	+·07	−·05	+·02	−·03	+·02	

5. *Colour-Magnitude Curve of the Pleiades Cluster Stars.*—Hertzsprung has found (*loc. cit.*, p. 27) that, for the Pleiades cluster stars with magnitude between $m = 4{\cdot}5$ and $m = 11{\cdot}0$, the relation between I_λ and m_{ph} is nearly linear. He derived the formula

$$I_\lambda = -{\cdot}662 + {\cdot}0945 m_{ph}.$$

With the help of my list in the *B.A.N.*, No. 49, vol. **2**, we may extend the curve down to $m = 14{\cdot}9$. It appears that for these fainter stars the colour-magnitude relation is no longer a linear one. The increase of colour with magnitude is larger than would be expected from Hertzsprung's formula. Table IV. gives the observed values of colour, the computed values, and the differences Obs.-Comp. A curve giving the mean relation of colour and magnitude has been published in *Hemel en Dampring* (**22**, 1924, p. 87). A part of that curve is also given in fig. 1.

TABLE IV.

Colour of Pleiades Cluster Stars.

m.	5·3.	6·3.	7·3.	8·3.	9·3.	10·3.	11·3.	12·3.	13·3.	14·3.	15·3.
Iλ obs.	−·20	−·08	+·10	+·15	+·21	+·35	+·55	+·73	+·95	+1·18	
Iλ comp.	−·09	·00	+·09	+·19	+·28	+·38	+·47	+·57	+·66	+ ·76	
O.–C.	−·11	−·08	+·01	−·04	−·07	−·03	+·08	*+·16*	*+·29*	+ *·42*	

6. *Colour-Magnitude Curve in Kr. VII., VIII., and Pleiades Background.*—There is something arbitrary in combining these three regions. This is only partly justified by the fact that the colour-magnitude relation in the three regions is exactly the same. These relations appear in Table V. As before, final mean values were derived. A least-square solution gives

$$I_\lambda = + {\cdot}170 + {\cdot}0253 m_{ph}.$$

In the last three lines of Table V. the observed and computed values of colour are compared.

TABLE V.

Mean Colour in Kr. VII., VIII., and Pleiades Field.

m.	6·3.	7·3.	8·3.	9·3.	10·3.	11·3.	12·3.	13·3.	14·3.	15·3.	16·3
Kr. VII.	+·85	..		+·40	+·55	+·45	+·40	+·42	+·47	+·58	+·63
	(1)			(2)	(7)	(7)	(22)	(53)	(105)	(189)	(287)
Kr. VIII.	..	..		+·10	+·75	+·40	+·41	+·50	+·48	+·59	
				(2)	(2)	(19)	(27)	(49)	(104)	(116)	
Pleiades	..	..		+·70	+·50	+·35	+·41	+·46	+·52	+·53	
				(2)	(10)	(22)	(46)	(82)	(195)	(263)	
Mean	+·85	..		+·40	+·54	+·38	+·41	+·47	+·50	+·56	+·63
	(1)			(6)	(19)	(48)	(95)	(184)	(404)	(568)	(287)
I_λ comp.	+·35	+·37		+·40	+·42	+·45	+·47	+·50	+·52	+·55	+·57
O.–C.	+·50	..		·00	+·12	−·07	−·06	−·03	−·02	+·01	+·06

7. *Colour-Magnitude Curve in Kr. I. and III.*—These two regions are of special interest, as they are situated in the dark parts of the Milky Way, in the immediate surroundings of the rich Scutum cloud. In Table VI. I have given the colour-magnitude curve in each region separately and their weighted mean. The computed values were found from the formula

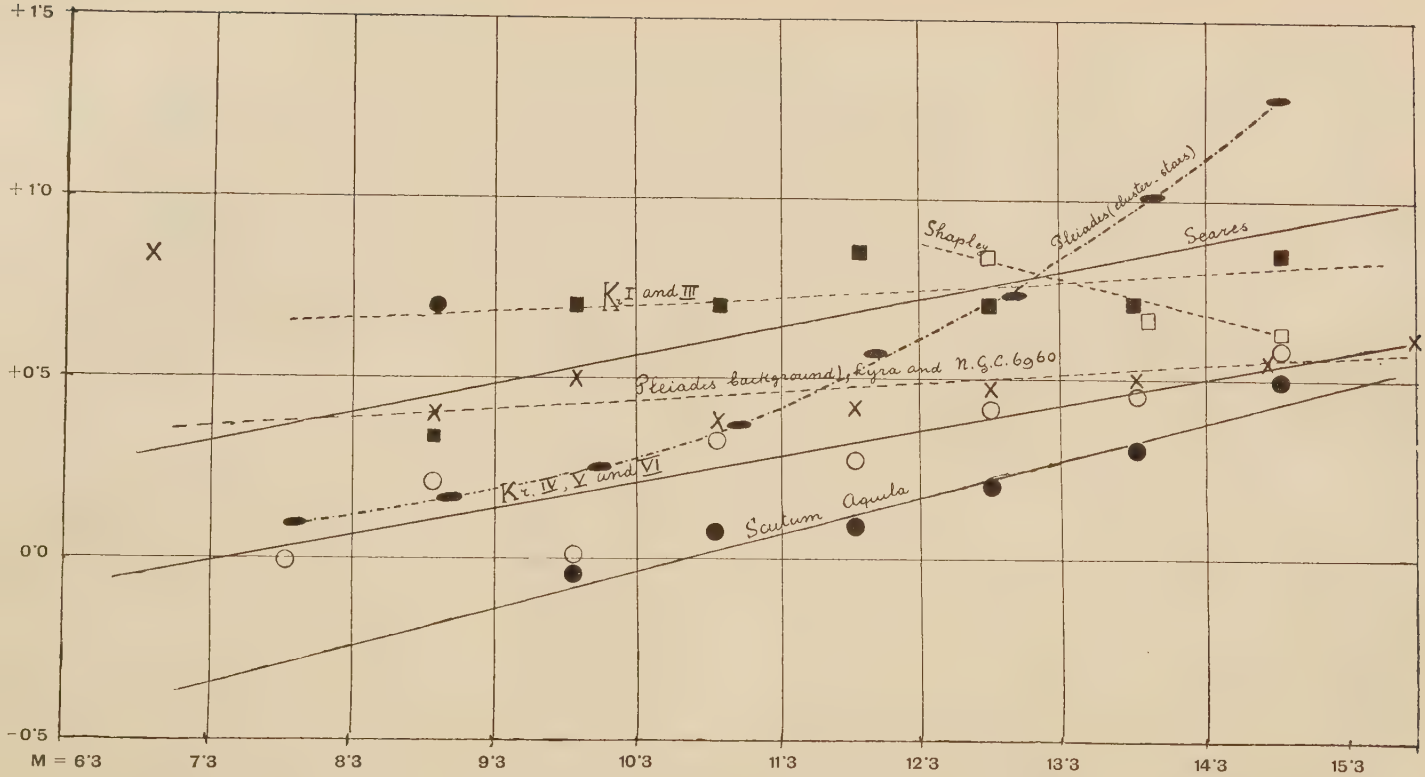
$$I_\lambda = + \cdot 661 + \cdot 0063 m_{ph}.$$

From the values in Table VI. and from the formula we conclude (*a*) that the colour index is nearly a constant, and (*b*) that the colour index in these two regions is very high.

TABLE VI.

Mean Colour in Kr. I. and III.

m.	8·3.	9·3.	10·3.	11·3.	12·3.	13·3.	14·3.	15·3.
Kr. I.	..	+·95	+·70	+1·00	+·60	+·65	+·80	
		(1)	(2)	(3)	(4)	(8)	(14)	
Kr. III.	+·35	+·45	..	+ ·75	+·80	+·70	+·80	
	(1)	(1)	..	(4)	(10)	(14)	(18)	
Mean	+·35	+·70	+·70	+ ·86	+·70	+·68	+·80	
	(1)	(2)	(2)	(7)	(14)	(22)	(32)	
I_λ comp.	+·71	+·72	+·73	+ ·73	+·74	+·74	+·75	
O.–C.	−·36	−·02	−·03	+ ·13	−·04	−·06	+·05	



Black circles	= mean colour in Scutum (Aquila).		Black squares	= mean colour in regions Kr. I. and III.
Open circles	= ,, ,, regions Kr. IV., V., VI.		Open squares	= ,, ,, Shapley's regions.
Crosses	= ,, ,, Pleiades, Lyra, and N.G.C. 6960.		Black ellipses	= ,, ,, the Pleiades group stars.

Fig. 1.—Relation of Mean Colour and Magnitude.

8. *Explanation of Fig.* 1.—In the Tables VII. and VIII. I have compiled the results obtained above. Table VII. contains the different final values of the observed colour; Table VIII. gives the different linear formula. In this latter table I have also inserted Seares' formula for the whole sky at large.

From the data in Tables VII. and VIII. fig. 1 was drawn. The values of colour index were plotted against magnitude. The rapid increase of the colour of the Pleiades cluster stars, which has been remarked previously, is very prominent in the figure. A rapid increase of the colour with magnitude is also indicated in the Scutum-Aquila curve. The different points through which this curve has been drawn clearly show that we are not sure of the colour-magnitude curve remaining linear when still fainter stars are taken into account.

TABLE VII.

Survey of Mean Colour.

Region. \ *m*.	7·3.	8·3.	9·3.	10·3.	11·3.	12·3.	13·3.	14·3.	15·3.	16·3.	$N_{m=15·3}$ per Sq. Degree.
Scutum-Aquila	..	+·70	−·05	+·08	+·09	+·21	+·30	+·53	..		1778
Cepheus	0·00	+·17	+·11	+·33	+·28	+·43	+·46	+·59	..		204
Kr. VII., VIII., Pleiades (background).	..	+·40	+·54	+·38	+·41	+·47	+·50	+·56	+·63		292
Kr. I., III.	..	+·35	+·70	+·70	+·86	+·70	+·68	+·80	..		57
Shapley	..	..	..	..	..	+·85	+·70	+·59			
Pleiades cluster	+·01	−·04	−·07	−·03	+·08	+·16	+·29	+·42			

TABLE VIII.

The Different Colour Curves.

Scutum, Aquila	$I_\lambda = -1·120+0·1051m_{ph}$
Cepheus	$I_\lambda = -0·587+0·0678m_{ph}$
Kr. VII., VIII., Pleiades	$I_\lambda = +0·170+0·0253m_{ph}$
Kr. I., III.	$I_\lambda = +0·661+0·0063m_{ph}$
Pleiades cluster, m = 4·5–11·0	$I_\lambda = -0·662+0·0945m_{ph}$
Seares	$I_c = -0·18+0·071m_{ph}$

Shapley's curve for the galactic stars is not in keeping with any of the other curves. The high value of the colour in the regions Kr. I. and III. is also very apparent.

Seares' mean curve gives for all magnitudes a colour index which is too large. Seares ascribes this to the fact that all regions considered here are of very low galactic latitude. Perhaps the most interesting feature of fig. 1 is that nearly all curves have a definite tendency to converge towards one point (about m = 16·5 and I_λ = + ·60). It would be interesting to know whether the colour indices remain equal beyond this point or diverge again.

9. *Frequency of Different Colour Indices.*—The distribution of the different colour indices is represented in fig. 2, where the percentages of the different colours are shown. For the brighter stars ($m<12{\cdot}3$) all regions were combined, with the exception of the Scutum-Aquila group, for which a separate curve has been given. For the fainter stars ($m = 12{\cdot}3$ to $15{\cdot}3$) each region was treated separately. I have also given the general distribution of the colour indices of the brighter stars ($m<8{\cdot}5$) in the Henry Draper Catalogue (in longitudes 330° to 30° and latitudes − 10° to + 10°). The colour indices corresponding to the different spectral types were taken from Schwarzschild's table (*loc. cit.*).

From the different curves in fig. 2 we draw the following conclusions :—

(*a*) The increase of frequency of the blue stars is rather sudden ; on the other hand, the frequencies of the colour indices gradually diminish towards the red.

(*b*) Proceeding from the brighter to the fainter stars, the maximum in the frequency curve is shifted towards the red. For the stars in the Henry Draper Catalogue ($m<8{\cdot}5$) this maximum is found at about $I_\lambda = + 0{\cdot}2$; for the brighter stars ($m<12{\cdot}3$) in the exceptional blue Scutum region also at about $I_\lambda = + 0{\cdot}2$; for the brighter stars in the other regions it is $I_\lambda = + 0{\cdot}4$. For the fainter stars ($m = 12{\cdot}3$ to $15{\cdot}3$) the following maxima are found : Scutum (Kr. II.), + 0·3 ; star-clouds near M. 11 (Shapley), + 0·4 ; N.G.C. 6960 (Kr. VII.), Lyra (Kr. VIII.), and Pleiades background, + 0·5 ; Cepheus (Kr. IV., V., and VI.), + 0·5 ; finally, Kr. I. and III., + 0·8.

(*c*) In the rich regions we find the maximum frequency at a lower colour value than in the poorer ones. This appears from the numbers given in point *b* in which the different regions were given in order of decreasing richness.

(*d*) For the fainter stars the maxima are much more pronounced than for the brighter ones.

(*e*) Comparing Shapley's frequency curve near M. 11 with that in Scutum, we see that the general shape of the two curves is the same. The maximum in Shapley's curve is less pronounced, while, on the other hand, the frequency of yellow stars is larger than in Scutum.

(*f*) In Scutum the bulk of the stars have colour indices from + ·10 to + ·50 (colour classes *a*, *f*, *g*) ; in N.G.C. 6960, Lyra, and Pleiades from + ·20 to + ·70 (*f*, *g*, *k*) ; in Cepheus from + ·30 to + ·70 (*f*, *g*, *k*) ; and in Kr. I. and III. from + ·40 to + 1·2 (*g* and *k*). In the region examined by Shapley the colour frequencies are distributed fairly evenly.

10. *Mean Colour of the Sky.*—The total amount of light $L(m)$ emitted by stars of one apparent magnitude m is

$$L(m) = A(m)e^{-0{\cdot}4m}dm \quad . \quad . \quad . \quad (1)$$

where $A(m)$ is the apparent luminosity curve.

$$A(m) = e^{a+bm-cm^2}dm \quad . \quad . \quad . \quad (2)$$

So we have

$$L(m) = e^{a+bm-cm^2-0{\cdot}4m}dm \quad . \quad . \quad . \quad (3)$$

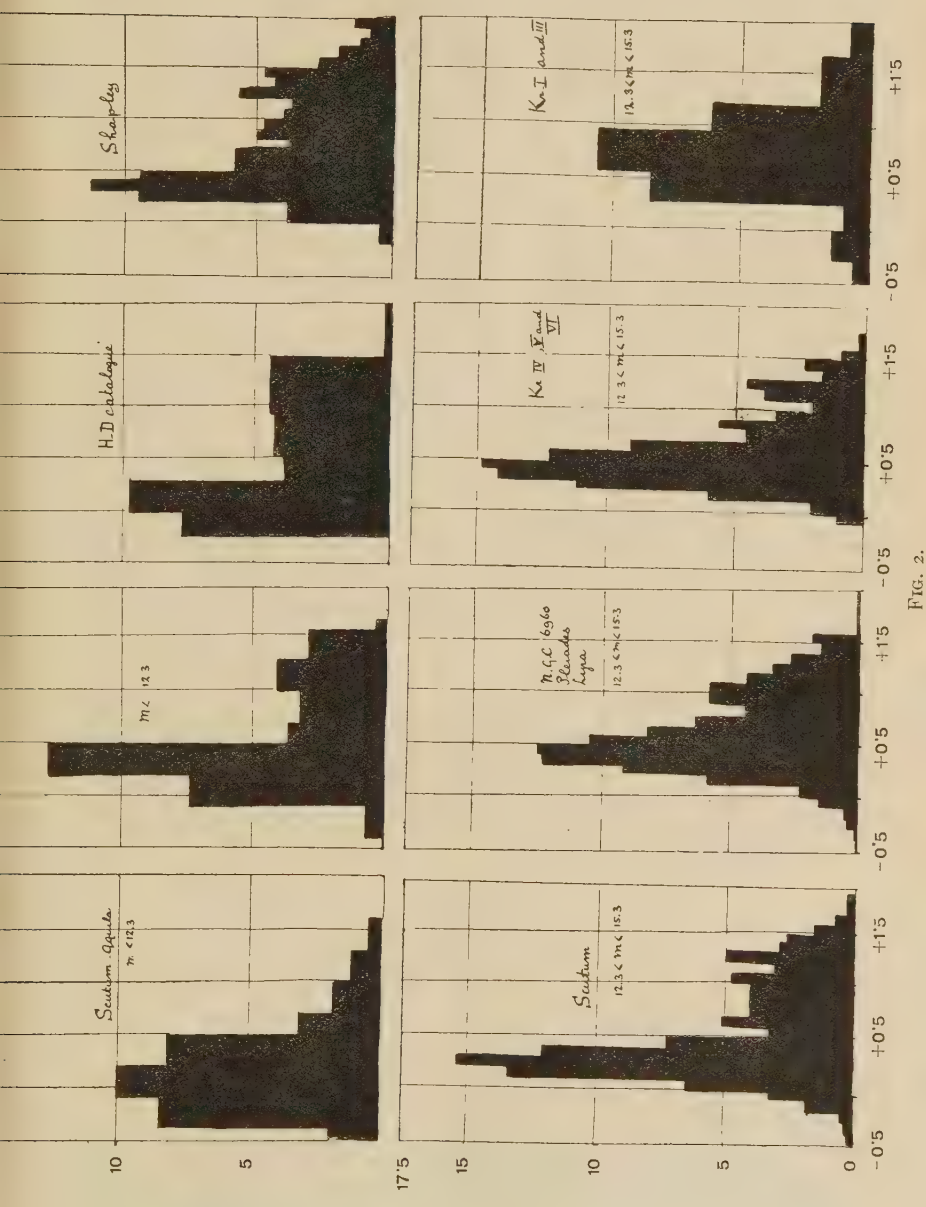

Scutum Aquila
m < 12.3
H.D catalogue
m < 12.3
Shapley
Scutum
12.3 < m < 15.3
N.G.C 6940
Pleiades
Lyra
12.3 < m < 15.3
Ku IV and V
12.3 < m < 15.3
Ku I and III
12.3 < m < 15.3
10
5
17'5
15
10
5
0
-0'5
+0'5
+1'5
-0'5
+0'5
+1'5
-0'5
+0'5
+1'5
-0'5
+0'5
+1'5

FIG. 2.

If we use our linear formula for the colour index,

$$I_\lambda = A + Bm \quad . \quad . \quad . \quad . \quad (4)$$

the mean colour of the scattered starlight would be given by formula (5).

$$I_\lambda = \frac{\int_{-\infty}^{+\infty} e^{a+bm-cm^2-0.4m} \times (A+Bm)dm}{\int_{-\infty}^{+\infty} e^{a+bm-cm^2}dm} \quad . \quad . \quad (5)$$

I do not expect any reliable results from (5), as it is certainly not permissible to extend the formula (4) indefinitely towards brighter and fainter magnitude. Therefore I have derived the mean colour in a different manner.

From (3) we compute the fraction of the total starlight emitted by stars with magnitude from 6·3 to 7·3, from 7·3 to 8·3, . . ., 16·3 to 17·3. The mean colour of the different regions was found by multiplying these fractions with the mean colour derived for each magnitude in them. If we divide the sum of these products by the sum of the fractions the mean colour is found.

The fraction of light emitted by stars with $m>17·3$ is negligible. Stars brighter than $m = 6·3$ were omitted, in order to make our results comparable to those obtained by others. The colours for the stars with m from 15·3 to 17·3 were found by introducing the assumption that for these two magnitudes the linear relation (4) may be extrapolated.

The mean values of colour thus obtained appear in Table IX. In this table the colour of Scutum is based on my values only, as Peterson gives no colours beyond $m = 13·0$.

In Table IX. two values of the colour are given; the second was obtained after neglecting the brightest magnitude in each region. This causes large variations, which makes us conclude that the weight of the numbers inserted in Table IX. is not large. I have compared my value of mean colour in Scutum with those previously obtained by Dr. A. Pannekoek and by Fath.

TABLE IX.

Mean Colour of the Sky.

Region.	Mean Colour.	Mean Colour.
Scutum	+·38	+·36
Cepheus	+·29	+·36
Kr. VII., VIII., Pleiades	+·52	+·49
Kr. I. and III.	+·69	+·81

Dr. Pannekoek has derived the value + 0·43 by comparing the visual brightness with the photographic. The latter was obtained from extrafocal images (*B.A.N.*, **44**, vol. **2**, p. 23). In 1912 E. A. Fath photographed the integrated spectrum of some galactic clouds

(Sagittarius, Scutum, Cygnus). It was found " approximately of solar type." More recent investigations confirm this result. Our own value indicates a less advanced type.

It may be noted that the values in Table IX. do not differ very much. The regions Kr. I. and III. have a very advanced type of colour.

Haarlem, Holland :
1926 December.

A Mechanical Solution of Kepler's Equation. By Y. Ueta.

(*Communicated by the Secretaries.*)

Many methods have been proposed—analytical, graphical, and mechanical—for the solution of Kepler's equation, namely,

$$M = E - e \sin E.$$

The following new method of solution is due to a very simple principle. The principle is so simple that I hesitated to claim originality ; but so far as I am aware, a similar method has not been published previously.

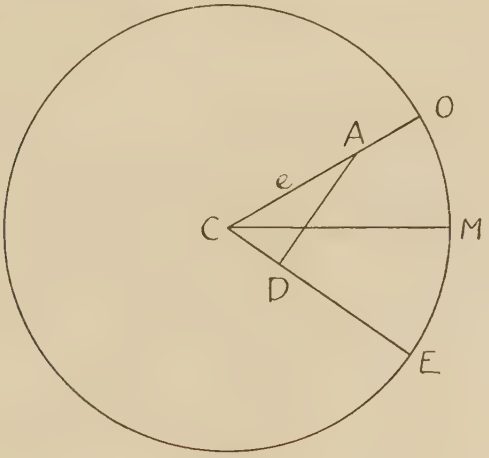


Fig. 1.

Draw a circle of an unit radius, having its centre at C (fig. 1), and let a radius CO be the initial line from which the angle is measured. Now take a point A on CO, such that CA is equal to the eccentricity e. Then draw another radius CM, subtending the given angle M at C with the initial line.

The point E is to be selected so that the arc ME is equal to the

perpendicular distance from the point A to the radius CE. This process may be carried out easily by a roller similar to that of a planimeter.

Now, we have

$$\angle OCM = \angle OCE - \angle MCE.$$

Let the angle OCE be E, then the perpendicular distance AD is equal to $e \sin E$, and it is equal to the arc ME, or, in other words, the angle MCE is equal to $e \sin E$.

Hence we have $M = E - e \sin E$, *i.e.* the angle OCE is the required eccentric anomaly.

The mechanical construction based on this principle can be made from the following parts :—

1. *A circular disc* graduated along 180° of its circumference.
2. *A revolving bar* which carries a roller, similar to that of a plani-

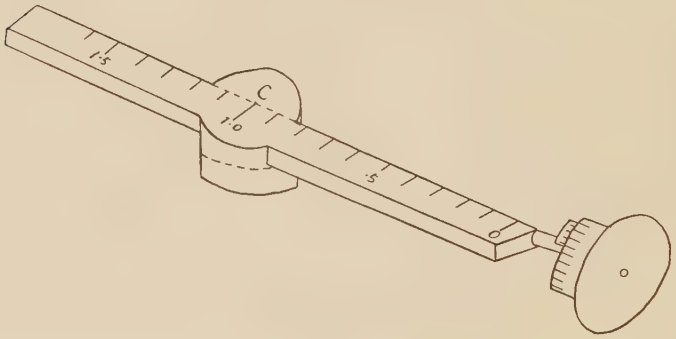


Fig. 2.

meter, at one end, and revolves close to the disc, with its centre of revolution coincident with the centre of the disc. The distance of the roller from the centre is so adjusted that the reading of the roller is 3·1416 when the bar has revolved 180°.

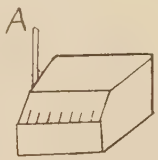


Fig. 3.

3. *An "A" point carrier* (fig. 3), movable along the groove, the middle line of which is coincident with the initial line.

4. *A pediometer* pivoted at A, and kept always perpendicular to the edge of the revolving bar CE during the operation.

The graduation must be as follows :—

(*a*) The edge of the groove must be graduated from zero to unity outwards from the centre. By using the vernier on the pivot carrier

we can set it accurately at a distance from the centre equal to the eccentricity e.

(*b*) The pediometer is graduated from zero to unity, starting from the point A.

(*c*) For the revolving bar, we take a point on the side of the roller, at an unit distance from the centre. Starting from that point, we graduate towards the other side over the centre. Then, the reading of the point D (where the pediometer intersects the bar perpendicularly) gives directly the value of

$$1 - e \cos \mathrm{E}.$$

Consequently, if we compute M_o, such that

$$\mathrm{M}_o = \mathrm{E} - e \sin \mathrm{E},$$

we can get readily the correction for the value of E so found, by the following expression,

$$\Delta \mathrm{E} = \frac{\mathrm{M} - \mathrm{M}_o}{1 - e \cos \mathrm{E}},$$

or $(\mathrm{M} - \mathrm{M}_o)$ divided by the reading of the point D.

Kyoto University Observatory :
1926 *October* 29.

Some Remarks on the Theory of Radiative Equilibrium in the Outer Layers of the Stars (in reference to the work of Professor E. A. Milne). By V. A. Ambarzumian and N. A. Kosirev.

§ 1. Professor E. A. Milne, in his very interesting paper "Radiative Equilibrium in the Outer Layers of a Star," published by him in 1921 March (*Monthly Notices of the R.A.S.*, pp. 361-375), derives the following equation, which characterizes the state of radiative equilibrium in the outer layers of stars, the generation of energy being absent,

$$2\mathrm{C}'(\tau) = \int_0^{\tau} \frac{\mathrm{C}(\tau + y) - \mathrm{C}(\tau - y)}{y} e^{-y} dy + \int_{\tau}^{\infty} \frac{\mathrm{C}(\tau + y)}{y} e^{-y} dy . \quad (1)$$

In the above equation

$$\tau = \int_0^x k\rho dx$$

where x is the height of the layer (the zero-point is taken on the surface), ρ the density, and k the coefficient of the absorption of the rays, which are going along the normal in the layer to be examined. Also,

$$\mathrm{C}(\tau) = \int_0^{\tau} \mathrm{B}(t) dt ; \qquad \mathrm{C}'(\tau) = \mathrm{B}(\tau) \quad . \quad . \quad (2)$$

where $B(\tau)$ represents the intensity of the radiation of an absolutely black body at the temperature of the given layer, this intensity being expressed by the law of Stefan. Solving the equation (1), we obtain the expression of the function $C'(\tau)$, and consequently also the relation between the temperature and τ. Professor Milne tries to find the solution of the equation (1) by means of the method of successive approximation. He assumes the first approximation to be

$$C'(\tau) = a + 2b\tau,$$

which corresponds to the distribution of temperature in layers infinitely removed from the surface. He stops at the second approximation, considering $C'(\tau)$ to be clearly expressed by the following formula:—

$$C'(\tau) = B(\tau) = a + 2b\tau + \tfrac{1}{2}e^{-\tau}(b - a - b\tau) + \tfrac{1}{2}(a\tau + b\tau^2)\int_\tau^\infty \frac{e^{-y}}{y}dy \quad (3)$$

thus assuming the above expression for an approximate solution of the equation (1). But in this question Professor Milne commits an error, as this equation has only one solution identically equal to zero,

$$C'(\tau) \equiv B(\tau) \equiv 0 \quad . \quad . \quad . \quad . \quad (4)$$

This indicates that radiative equilibrium without the generation of energy cannot take place if the intensity of radiation differs from zero.

In order to prove the relation (4), we shall show first that the solutions of the equation (1) will be at the same time the solutions of the following homogeneous integral equation

$$B(\tau) = \tfrac{1}{2}\int_0^\infty \mathrm{E}i\,|\tau - t|\,B(t)dt \quad . \quad . \quad . \quad (5)$$

where we adopt the notation

$$\mathrm{E}ix = \int_x^\infty \frac{e^{-\xi}}{\xi}d\xi.$$

This will be the case if the equation (5) follows from equation (1), which we are about to prove. Adding to and subtracting from the right-hand side of the equation the quantity

$$C(\tau)\int_\tau^\infty \frac{e^{-y}}{y}dy,$$

we find

$$2C'(\tau) = \int_0^\infty \frac{C(\tau + y) - C(\tau)}{y}e^{-y}dy - \int_0^\tau \frac{C(\tau - y) - C(\tau)}{y}e^{-y}dy + C(\tau)\int_\tau^\infty \frac{e^{-y}}{y}dy \quad (6)$$

Moreover we see that

$$\frac{C(\tau + y\mu)}{y} = \int C'(\tau + y\mu)d\mu \quad \text{and} \quad \frac{C(\tau - y\mu)}{y} = \int C'(\tau - y\mu)d\mu.$$

By these relations the subintegral functions in equation (6) are transformed into

$$\frac{C(\tau+y)-C(\tau)}{y} = \left[\frac{C(\tau+y\mu)}{y}\right]_0^1 = \int_0^1 C'(\tau+y\mu)d\mu$$

$$\frac{C(\tau-y)-C(\tau)}{y} = \left[\frac{C(\tau-y\mu)}{y}\right]_0^1 = -\int_0^1 C'(\tau-y\mu)d\mu$$

$$\frac{C(\tau)}{y} = \left[\frac{C(\tau-y\mu)}{y}\right]_{\tau/y}^0 = \int_{\tau/y}^0 C'(\tau-y\mu)d\mu$$

since from the first of the equations (2) it follows that $C(0) = 0$. Substituting in equation (6) the relations thus obtained, we find

$$2C'(\tau) = \int_0^\infty e^{-y}dy\int_0^1 C'(\tau+y\mu)d\mu + \int_0^\tau e^{-y}dy\int_0^1 C'(\tau-y\mu)d\mu + \int_\tau^\infty e^{-y}dy\int_0^{\tau/y} C'(\tau-y\mu)d\mu \quad (7)$$

The second term of the right-hand side of the equation is a double integral extended over the rectangle ($0\leqslant\mu\leqslant 1$; $0\leqslant y\leqslant\tau$) in the plane $y\mu$; the third member is a double integral with the same subintegral function, this integral being extended over a region which is limited by one side of the former rectangle and by $\tau = y\mu$. Thus we may replace these two integrals by one, extended over a new region composed of the two former. Altering the order of integration, equation (7) is transformed into

$$2C'(\tau) = \int_0^1 d\mu\int_0^\infty C'(\tau+y\mu)e^{-y}dy + \int_0^1 d\mu\int_0^{\tau/\mu} e^{-y}C'(\tau-y\mu)dy.$$

In the first integral, put

$$\tau+y\mu = t; \qquad dy = 1/\mu\, dt;$$

and in the second,

$$\tau-y\mu = t; \qquad dy = -1/\mu\, dt.$$

We obtain

$$2C'(\tau) = \int_0^1 d\mu\int_\tau^\infty C'(t)\frac{e^{-\frac{t-\tau}{\mu}}}{\mu}dt + \int_0^1 d\mu\int_0^\tau C'(t)\frac{e^{-\frac{\tau-t}{\mu}}}{\mu}dt.$$

Putting

$$1/\mu = \xi; \qquad d\mu = -\frac{d\xi}{\xi^2}$$

and, altering the order of integration, we find

$$2C'(\tau) = \int_\tau^\infty dt\int_1^\infty C'(t)\frac{e^{-(t-\tau)\xi}}{\xi}d\xi + \int_0^\tau dt\int_1^\infty C'(t)\frac{e^{-(\tau-t)\xi}}{\xi}d\xi,$$

but, as according to our notation,

$$Ei(t-\tau) = \int_{t-\tau}^\infty \frac{e^{-\xi}}{\xi}d\xi = \int_1^\infty \frac{e^{-(t-\tau)\xi}}{\xi}d\xi \quad \text{and} \quad Ei(\tau-t) = \int_1^\infty \frac{e^{-(\tau-t)\xi}}{\xi}d\xi,$$

we finally obtain

$$B(\tau) = \tfrac{1}{2}\int_0^\infty Ei|\tau - t|\,B(t)dt \quad . \quad . \quad . \quad (8)$$

because $B(t) = C'(t)$, which we had to prove. Now let us prove the statement that the homogeneous integral equation has not any continuous solutions which are not identically zero.

§ 2. It is readily calculated that

$$\tfrac{1}{2}\int_0^\infty Ei|\tau - t|\,dt = 1 - \tfrac{1}{2}(e^{-\tau} - \tau Ei\tau) \quad . \quad . \quad (9)$$

Let us show that in the whole region $0 \leqslant \tau < \infty$ we have

$$\tfrac{1}{2}(e^{-\tau} - \tau Ei\tau) > 0 \quad \text{or} \quad e^{-\tau} > \tau Ei\tau \quad . \quad . \quad . \quad (10)$$

In fact

$$e^{-\tau} = \int_\tau^\infty e^{-\xi}d\xi; \qquad \tau Ei\tau = \tau\int_\tau^\infty \frac{e^{-\xi}}{\xi}d\xi = \int_\tau^\infty \frac{\tau}{\xi}e^{-\xi}d\xi.$$

As in both integrals the subintegral functions are positive, and as the second function differs from the first by the factor $\frac{\tau}{\xi} \leqslant 1$, the inequality is proved.

Let us denote the positive function $\frac{1}{2}(e^{-\tau} - \tau Ei\tau)$ by $\psi_1(\tau)$. We may write

$$\tfrac{1}{2}\int_0^\infty Ei|\tau - t|\,dt = 1 - \psi_1(\tau) = \phi_1(\tau) \quad . \quad . \quad (11)$$

where $\phi_1(\tau)$ is positive, as $Ei|\tau - t|$ is positive on the whole plane τt. We form an infinite sequence of functions connected together by the relation

$$\tfrac{1}{2}\int_0^\infty Ei|\tau - t|\,\phi_{n-1}(t)dt = \phi_n(t) \quad . \quad . \quad . \quad (12)$$

All the functions of this sequence are positive since the kernel $Ei|\tau - t|$ and the function $\phi_1(\tau)$ are positive. Thus $\phi_n(\tau) > 0$. We had $\phi_1(\tau) = 1 - \psi_1(\tau)$, where $\psi_1(\tau)$ is a positive function. If we substitute this equation in (12) we obtain, having in view (11),

$$\phi_2(\tau) = 1 - \psi_1(\tau) - \psi_2(\tau)$$

where

$$\psi_2(\tau) = \tfrac{1}{2}\int_0^\infty Ei|\tau - t|\,\psi_1(t)dt$$

is also a positive function. Continuing it, we obtain for $\phi_n(\tau)$ the formula

$$\phi_n(\tau) = 1 - [\psi_1(\tau) + \psi_2(\tau) + \ldots + \psi_n(\tau)] > 0 \quad . \quad (13)$$

where

$$\psi_n(\tau) = \tfrac{1}{2}\int_0^\infty Ei|\tau - t|\,\psi_{n-1}(t)dt.$$

Evidently the sequence of the functions $\phi_n(\tau)$ converges. In fact at every value of τ this sequence is monotonically decreasing, but all its members are still greater than zero. Let us denote the limit of this series by $\Phi(\tau)$. Let us prove that our sequence of functions uniformly converges. For this purpose let us first show that out of it one may extract a uniformly converging series.

Our sequence of functions satisfies the conditions which have been formulated by Courant and Hilbert as sufficient to make possible the extraction of a uniformly converging sequence.* First of all it is uniformly limited because all $|\phi_n(\tau)| < 1$. Secondly it is uniformly continuous because

$$\phi_n(\tau+\eta) - \phi_n(\tau) = \tfrac{1}{2}\int_0^\infty [\mathrm{E}i|\tau+\eta-t| - \mathrm{E}i|\tau-t|]\phi_{n-1}(t)dt$$
$$= \phi_{n-1}(\bar{t})[\phi_1(\tau+\eta) - \phi_1(\tau)]$$

where the factor $\phi_{n-1}(\bar{t})$ is taken outside the sign of integration, according to the theorem of the mean. Since all $\phi_{n-1}(\bar{t}) < 1$ from the uniform continuity of $\phi_1(\tau)$ there follows the uniform continuity of the whole sequence $\phi_n(\tau)$. Thus the sequence $\phi_n(\tau)$ is uniformly limited and uniformly continuous, consequently we are able to extract from it, according to the theorem of Courant and Hilbert, a uniformly converging sequence. It is obvious that the limit of this partial sequence will be the same as the limit of the whole sequence, viz. $\Phi(\tau)$. Let us show that the whole sequence as well converges uniformly. In fact any sufficiently far term of the whole sequence is enclosed between two terms ϕ_{n_i} and $\phi_{n_{i+1}}$ of the partial sequence. Since for all the positive τ we have

$$|\Phi(\tau) - \phi_{n_i}(\tau)| < \epsilon \qquad |\Phi(\tau) - \phi_{n_{i+1}}(\tau)| < \epsilon \quad . \qquad . \quad (14)$$

so by virtue of the monotonity of the whole sequence for n, which is enclosed between n_i and n_{i+1}, we have also

$$|\Phi(\tau) - \phi_n(\tau)| < \epsilon \quad . \quad . \quad . \quad . \quad (15)$$

Thus the series of functions

$$\phi_1(\tau), \qquad \phi_2(\tau), \qquad \ldots, \qquad \phi_n(\tau), \qquad \ldots$$

converges uniformly for all positive values τ. Consequently also the sequence of functions

$$1 - \phi_1(\tau), \qquad 1 - \phi_2(\tau), \qquad \ldots, \qquad 1 - \phi_n(\tau), \qquad \ldots$$

converges uniformly for all the values τ. As

$$1 - \phi_n(\tau) = \psi_1(\tau) + \psi_2(\tau) + \ldots + \psi_n(\tau)$$

the series $\psi_1(\tau) + \psi_2(\tau) + \ldots$ converges uniformly, all τ being positive. Let us show that this series if multiplied by $\mathrm{E}i|\tau - t|$ admits an integration term by term in the whole interval, that means, if we put

$$\Psi(\tau) = \psi_1(\tau) + \psi_2(\tau) + \ldots + \psi_n(\tau) + \ldots \quad . \quad (16)$$

* R. Courant und D. Hilbert, *Methoden der Mathematischen Physik*, I, pp. 39–41.

then

$$\int_0^\infty \mathrm{E}i\,|\tau - t|\,\Psi(t)dt = \int_0^\infty \mathrm{E}i\,|\tau - t|\,\psi_1(t)dt + \int_0^\infty \mathrm{E}i\,|\tau - t|\,\psi_2(t)dt + \ldots \quad (17)$$

The integral on the left indubitably exists, since $\Psi(\tau)$ is continuous, and is limited, and $\mathrm{E}i\,|\tau - t|$ is integrable from zero to infinity. In virtue of the uniform convergence of the series (16), the integration term by term is possible between finite limits

$$\int_0^b \mathrm{E}i\,|\tau - t|\,\Psi(t)dt = \int_0^b \mathrm{E}i|\,\tau - t|\,\psi_1(t)dt + \int_0^b \mathrm{E}i\,|\tau - t|\,\psi_2(t)dt + \ldots$$

where b may be no matter how great, and therefore the left part will differ no matter how little from

$$\int_0^\infty \mathrm{E}i\,|\tau - t|\,\Psi(t)dt\,;$$

consequently also the right part will differ from the same integral no matter how little and thus, by increasing "b", will tend to it as a limit.

The possibility of an integration term by term of the series being proved,

$$\mathrm{E}i\,|\tau - t|\,\Psi(t) = \mathrm{E}i\,|\tau - t|\,\psi_1(t) + \mathrm{E}i\,|\tau - t|\,\psi_2(t) + \ldots \quad (18)$$

we find the solution of the following integral equation :—

$$\psi_1(\tau) = \phi(\tau) - \tfrac{1}{2}\int_0^\infty \mathrm{E}i\,|\tau - t|\,\phi(t)dt \quad . \quad . \quad (19)$$

in the form

$$\phi(\tau) = \Psi(\tau) = \psi_1(\tau) + \psi_2(\tau) + \ldots + \psi_n(\tau) + \ldots \quad (20)$$

It is easy to convince oneself of this by substituting this series in (19) and taking into consideration that

$$\psi_n(\tau) = \tfrac{1}{2}\int_0^\infty \mathrm{E}i\,|\tau - t|\,\psi_{n-1}(t)dt.$$

Thus the equation (19) has a thoroughly determinate solution $\Psi(\tau)$. But if the homogeneous equation

$$\mathrm{B}(\tau) = \tfrac{1}{2}\int_0^\infty \mathrm{E}i\,|\tau - t|\,\mathrm{B}(t)dt \quad . \quad . \quad . \quad (21)$$

should have a solution not identically equal to zero, then

$$\int_0^\infty \mathrm{B}(\tau)\psi_1(\tau)d\tau$$

should be equal to zero, as, if we multiply (19) by $\mathrm{B}(\tau)$, we obtain

$$\int_0^\infty \psi_1(\tau)\mathrm{B}(\tau)d\tau = \int_0^\infty \phi(\tau)\mathrm{B}(\tau)d\tau - \tfrac{1}{2}\int_0^\infty \mathrm{B}(\tau)d\tau\int_0^\infty \mathrm{E}i\,|\tau - t|\,\phi(t)dt \quad (22)$$

whence, taking into consideration (21) and altering the order of integration, we obtain

$$\int_0^\infty B(\tau)\psi_1(\tau)d\tau = \int_0^\infty \phi(\tau)B(\tau)d\tau - \int_0^\infty \phi(t)B(t)dt = 0 \quad . \quad (23)$$

Thus the functions $B(\tau)$ and $\psi_1(\tau)$ must be orthogonal. As $\psi_1(\tau)$ is positive, the function $B(\tau)$ must have a negative value (and therefore without physical significance). Let us form a new continuous positive function $\chi(\tau)$, which differs from $\psi_1(\tau)$ in those regions where $B(\tau)$ is negative, $\chi(\tau)<\psi_1(\tau)$, and in other regions $\chi(\tau) = \psi_1(\tau)$. It is obvious that this function does not satisfy the condition of orthogonality of

$$\int_0^\infty \chi(\tau)B(\tau)d\tau = 0.$$

Meanwhile the equation

$$\chi(\tau) = \phi(\tau) - \tfrac{1}{2}\int_0^\infty Ei\,|\tau - t|\,\phi(t)dt$$

has a thoroughly determinate solution. Therefore in case there exists a solution (21) which cannot be identically equal to zero, the condition of orthogonality should take place, as it may be shown analogically to the above mentioned.

Thus, assuming the existence of a solution of the equation (21) which cannot be identically equal to zero, we have come to a contradiction. Such a solution does not exist, consequently there does not exist any continuous solution (1) different from zero.

Therefore the method used by Professor Milne is not applicable in this case.

Micrometrical Measures of Double Stars (21*st Series*).

By Rev. T. E. Espin and W. Milburn.

The Micrometrical Measures are given as in previous lists, those marked E being made with the 24-inch and the ones marked M with the 17¼-inch. The asterisk attached to a star in Column 1 denotes that additional information is given in the notes.

Name.	1900. R.A.	1900. Decl.	P.	D.	Mags.	Nts.	Date 1926.	
	h m	° ′	°	″				
Espin 312	0 12·0	+34 35	237·0	2·47	9·5 9·7	3	·283	E
h 622	20·7	34 14	131·1	19·44	9·0 9·2	2	·030	E
Espin 314	30·6	28 41	200·2	7·93	9·0 14·0	2	·980	M
M 184 *	37·8	63 39	238·4	2·79	10·5 12·0	3	1927. ·005	M BC
			63·7	6·97	A = 10·0	2	·009	M AB

Name.	1900. R.A.	Decl.	P.	D.	Mags.	Nts.	Date 1926.	
	h m	° ′	°	″				
Σ 55	0 39·0	34 4	323·3	1·92	8·0 8·2	2	·033	E
Espin 316	47·3	32 43	294·0	3·00	9·2 10·5	2	·908	E
Espin 227	1 34·6	34 17	79·3	4·78	..	3	·059	E
Espin 320 *	46·5	33 25	160·3	2·62	9·0 10·5	1	·085	E AB
			255·5	10·42	C = 11·0	1	·085	E AC
Espin 322	59·6	32 39	88·6	2·96	9·4 10·0	1	·920	E
Σ 368	3 12·6	68 6	161·3	2·49	9·1 9·2	2	·104	M
Espin 275	36·3	36 49	301·2	3·12	9·6 10·2	1	·123	E
A.G. 71	36·6	65 47	241·6	8·04	9·0 9·2	1	·123	M
Espin 288	6 14·9	39 11	149·8	4·39	9·2 9·5	2	·203	E AB
			276·9	13·20	C = 12·0	2	·203	E AC
M 399	41·5	67 34	253·6	6·51	8·9 10·3	2	·119	M
h 3285 *	46·1	38 15	250·3	11·31	9·6 11·0	2	·194	E
h 3294	7 27·2	35 52	179·6	4·91	9·5 9·6	1	·200	E
Espin 299	8 25·8	34 56	218·5	4·69	11·0 11·5	4	·266	E BC
Espin 294	42·8	36 31	167·1	1·62	9·5 10·0	3	·264	E
Espin 295	42·8	35 21	311·2	3·62	9·7 12·0	4	·272	E
M 65	9 19·2	38 42	318·3	4·55	10·7 10·7	2	·279	E
h 3321	10 3·4	67 22	136·3	4·52	9·7 9·8	2	·229	M
Σ 1498 rej.	55·1	66 59	13·1	7·48	7·0 9·2	2	·260	M AB
			290·9	29·11	C = 9·1	2	·260	M AC
Espin 305	11 12·0	35 1	35·1	4·41	9·2 10·0	1	·280	E
Σ 1524	13·1	33 39	147·5	7·24	3·5 10·0	2	·267	E
Espin 434	13·4	35 32	245·2	7·16	9·3 14·0	1	·282	E
A.G. 174	17·1	65 16	106·3	2·37	9·0 9·3	2	·278	M
h 498 *	21·8	34 36	82·8	19·35	9·6 9·9	3	·270	E
M 410	12 10·4	64 32	37·0	5·93	..	3	·276	M
M 412	13 14·5	63 10	272·6	2·83	9·5 11·5	1	·280	M
h 264 *	17 4·1	36 5	204·2	12·94	9·5 13·0	4	·619	E
Ho 73	53·7	35 42	215·6	2·20	10·0 10·5	3	·606	E
Espin 344	53·6	33 52	32·3	9·20	8·9 9·5	2	·699	E
h 1313	18 2·2	28 42	307·3	12·92	9·0 10·5	3	·581	M
Espin 184	5·2	32 53	155·8	6·46	9·2 11·0	3	·692	E
Espin 185	7·4	32 57	285·7	6·56	8·9 9·2	2	·688	E
Espin 345	7·3	31 22	15·0	3·25	10·0 10·1	3	·708	E
Espin 347 *	17·2	32 17	59·1	1·85	9·2 9·3	2	·690	E
h 1337 *	37·1	31 29	156·9	8·87	8·3 10·0	2	·706	E
h 1340	38·7	32 25	78·1	13·12	9·5 11·5	2	·706	E

Name.	1900. R.A. h m	Decl. ° ′	P. °	D. ″	Mags.	Nts.	Date 1926.	
Hu 936	18 44·9	33 55	104·3	1·83	9·0 9·1	5	·671	E
Tarrant *	46·9	33 6	230·4	4·01	11·0 11·4	2	·723	E BC
			298·3	13·06	A = 9·5	2	·723	E AB
Σ 2470	19 5·1	34 36	270·3	13·66	7·0 8·7	2	·821	E
Espin 352	17·1	34 15	135·4	5·08	8·9 10·0	2	·706	E
Espin 484	20·8	28 44	329·6	7·84	8·8 13·7	3	·635	M AB
			334·8	24·23	C = 8·7	3	·635	M AC
β 1286 *	22·4	35 43	76·9	8·16	8·0 9·0	2	·638	E AB
			197·3	3·69	C = 12·5	4	·644	E BC
			99·6	6·91	..	2	·645	E AC
Espin 195 *	28·6	34 4	228·9	6·04	8·5 9·0	2	·710	E
Espin 196	29·2	33 5	51·6	6·24	9·0 11·5	3	·711	E
A.G. 232	31·0	35 5	276·0	10·68	8·5 9·0	2	·663	E
Scheiner 656	36·4	34 55	285·3	11·16	7·5 11·5	2	·715	E
Espin 243	58·2	35 6	286·2	4·35	9·5 11·5	2	·723	E
Espin 202 *	58·6	35 2	163·3	4·06	8·3 14·0	3	·781	E Aa
			106·4	4·35	9·7 10·5	3	·744	E Bb
			100·5	17·45	..	2	·732	E AB
			220·3	10·28	a′ = 13·0	1	·736	E Aa′
			164·0	11·95	C = 9·2	1	·728	E AC
Espin 24 *	20 1·9	35 19	240·4	10·33	8·5 14·0	3	·647	E AB
			81·9	16·85	C = 13·0	4	·656	E AC
Espin 25 *	2·3	35 29	126·3	8·62	8·0 14·0	4	·643	E AB
			297·4	10·77	C = 13·5	4	·643	E AC
			235·3	20·68	D = 8·0	2	·672	E AD
Espin 203	4·6	35 10	123·8	5·86	8·5 9·0	2	·723	E
β 430 *	7·7	35 42	18·2	1·16	9·2 9·3	1	·652	E AB
			173·6	7·60	a = 13·8	2	·653	E Aa
			50·2	17·33	C = 9·3	2	·677	E AC
Espin 244	10·6	35 7	298·0	3·94	12·0 13·0	4	·853	E CD
			9·4	4·89	B = 11·0	4	·853	E BC
			129·1	40·53	A = 7·0	1	·857	E AB
Arg: VI. 45	19·4	30 33	175·4	20·56	8·0 9·0	2	·883	E
Espin 363 *	20·7	30 14	281·1	2·87	9·5 9·6	2	·886	E
M 21	20·7	39 41	336·4	5·09	11·0 12·0	3	·827	E
M 22	21·7	39 43	229·5	6·12	10·5 11·0	2	·812	E
De 22 *	21·9	39 46	97·4	15·63	8·2 13·5	5	·840	E AC
Espin 504	24·1	28 40	92·1	5·44	9·5 10·0	2	·634	M

Name.	1900. R.A.	Decl.	P.	D.	Mags.	Nts.	Date 1926.	
	h m	° ′	°	″				
Espin 507	20 28·9	28 31	296·2	5·94	8·6 11·0	3	·719	M AB
			343·0	35·01	C = 9·3	2	·731	M AC
			227·0	39·30	D = 9·6	2	·731	M AD
			149·1	15·24	*d* = 11·0	2	·752	M D*d*
Espin 1680	29·0	39 35	26·6	2·70	9·7 11·0	3	·755	E
Espin 90 *	36·4	47 13	139·4	7·65	8·0 12·0	3	·694	E
Espin 508	36·9	29 4	237·8	2·53	9·0 10·2	2	·706	M AB
			225·4	17·70	C = 9·1	3	·704	M AC
M 23	38·5	40 19	43·9	7·66	8·5 10·6	2	·801	E
M 24	39·2	40 14	172·9	5·85	9·4 9·8	2	·801	E
Arg. 39 *	39·3	48 54	126·3	8·80	8·4 8·8	2	·677	E AB
			121·0	32·03	C = 12·0	2	·677	E AC
M 25	41·0	41 9	211·3	5·94	9·4 9·5	3	·806	E
Espin 32 *	21 3·1	47 15	153·2	15·80	4·5 13·8	4	·689	E
Dunér 3 *	6·6	28 32	200·3	6·01	9·2 9·3	2	·634	M
h 1652 *	26·0	33 38	37·8	13·33	..	3	·734	E
M 26	26·3	40 18	71·4	5·66	8·8 10·7	2	·801	E
Espin 379	28·9	29 48	302·3	8·86	9·1 9·9	3	·711	M
M 28	32·3	39 35	248·2	5·22	9·5 12·0	2	·821	E
Espin 520	34·6	27 59	40·8	6·64	9·5 9·7	3	·781	M
M 29	35·6	40 23	341·9	6·63	9·5 11·5	2	·821	E
Espin 523	49·1	26 33	96·5	5·48	9·4 9·5	3	·711	M
M 31	22 1·3	39 38	309·7	7·68	9·5 9·8	2	·812	E
Espin 387	5·0	32 53	267·5	1·54	10·0 10·0	7	·764	E
M	8·0	39 22	291·3	8·33	10·5 11·0	1	·920	E
Espin 388	8·8	31 38	262·1	7·20	9·3 10·5	4	·719	E
Espin 390	18·2	32 57	261·5	12·76	8·8 9·0	4	·699	E
8 Lacertæ	31·4	39 6	226·4	9·07	8·5 13·0	2	·874	E D*d*
Espin 265	39·3	33 6	5·0	8·89	9·0 9·6	2	·699	E
h 1819 *	46·5	28 43	319·8	4·25	10·7 12·0	2	·812	M BC
			74·2	16·28	A = 8·2	2	·812	M AB
M 33	49·9	38 14	298·0	5·77	9·4 10·7	2	·821	E
Espin 397	23 5·6	32 36	154·9	5·04	9·1 12·0	2	·847	E
Espin 399	24·3	29 17	207·7	8·04	9·5 12·0	3	·706	M
Espin 400	24·4	29 16	218·8	5·32	9·4 9·8	2	·757	M
Espin 402	34·8	32 5	88·4	4·82	9·5 13·0	3	·784	E
h 1908	42·0	35 4	68·7	18·97	..	2	·021	E
M 34	42·8	39 30	330·1	7·62	9·4 11·2	2	·842	E
M 35	44·6	38 24	223·3	4·72	9·6 10·5	3	·868	E

Notes.

M 184, $0^h\ 37^m{\cdot}8$. AB distance diminishing, BC decrease of angle.
Espin 320, $1^h\ 46^m{\cdot}5$. This is Hu 805, published as B.D. + 33°·311 by mistake.
h 3285, $6^h\ 46^m{\cdot}1$. This is B.D. + 38° ·1634.
h 498, $11^h\ 21^m{\cdot}8$. Probably B.D. + 34°·2223 with correction of + 1^m to B.D. place.
h 264, $17^h\ 4^m{\cdot}1$. The various measures suggest that this is not a case of P.M.
Espin 347, $18^h\ 17^m{\cdot}2$. Angle diminishing.
h 1337, $18^h\ 37^m{\cdot}1$. Angle diminishing.
Tarrant, $18^h\ 46^m{\cdot}9$. Alteration in the angles of both *comites*.
β 1286, $19^h\ 22^m{\cdot}4$. B and C having now separated sufficiently, I have connected C with A. The apparent P.M. of B is 0″·21 at P. 28°·8. Professor Aitken informs me that Hertzsprung finds the P.M. is really in A.
Espin 195, $19^h\ 28^m{\cdot}6$. This is Hu 946.
Espin 202, $19^h\ 58^m{\cdot}6$. The nearest *comes* was suspected with the 17¼-inch in 1904. There seems to be no change in the other stars, with the exception of B*b*, where the angle has diminished by 10°.
Espin 24, $20^h\ 1^m{\cdot}9$. A is the companion of the wide pair O$\Sigma\Sigma$ 199.
Espin 25, $20^h\ 2^m{\cdot}3$. AD is Sh 315. The angle of AB may have increased. Scheiner calls B 11·0 mag. It must photographically be some 3 mags. brighter than visually, and may be a bright line star.
β 430, $20^h\ 7^m{\cdot}7$. The faint *comes* was added with the 24-inch, and seems to have escaped attention so far. There is another more distant in the same direction.
Espin 363, $20^h\ 20^m{\cdot}7$. This is B.D. + 30°·4019.
De 22, $20^h\ 21^m{\cdot}9$. The *comes* was added by β. The angle appears to be increasing and the distance diminishing, but it is difficult to measure from its faintness.
Espin 90, $20^h\ 36^m{\cdot}4$. This star is left out in β's G.C.
Arg 39, $20^h\ 39^m{\cdot}3$. The movement seems to be in B, and the P.M. 0″·149 at P. 225°·0.
Espin 32 = 63 Cygni. This season the *comes* has been very faint.
Dunér 3, $21^h\ 6^m{\cdot}6$. This is B.D. + 28°·4014, not + 28°·4015 as given in β's G.C.
h 1652, $21^h\ 26^m{\cdot}0$. This is B.D. + 33°·4280.
h 1819, $22^h\ 46^m{\cdot}5$. Doo. measured a *comes*, 12·3 mag. at P. 208°·8, D. 5″·46. This was not seen. Professor Turner kindly examined an Oxford plate taken 1892 September 24, and finds a faint *comes* at P. 305°, D. 4″·5. Perhaps Doo.'s Angle should be P. 308°·8. If this is so, the angle has increased.

Stars Faint or Missing.

		°	h m s	° ′		
(1)	B.D.	+ 34·553	2 50 53·1	+ 34 19·8	mag. 9·5	1925 Dec. 3. Not seen. E.
(2)		37·855	3 51 4·9	37 35·5	9·5	1926 Jan. 4. No star here. E.
(3)		34·2226	9 20 6·2	34 18·5	9·5	Apr. 7, 10. Not above 12 mag. E.
(4)		36·2876	17 24 13·5	36 6·7	9·3	Aug. 1. No star seen. E.
(5)		34·3125	18 1 48·7	34 49·4	9·5	Aug. 21. No star seen. E.
(6)		35·3368	18 44 20·2	35 2·0	9·5	Aug. 1. No star seen. E.
(7)		28·3206	19 2 22·8	28 57·8	9·5	Aug. 20, 10·5 mag. Aug. 21, 11·0 mag. M.
(8)		29·3770	19 44 44·0	29 1·6	9·3	July 31. No star seen. M.

Stars Faint or Missing—continued.

(9) B.D.	° ′ + 28 4425	h m s 22 32 13·4	° ′ + 28 29·6	mag. 9·0	1926 Sept. 25, 10·5 mag. *Oxford Astrog. Cat.*, 3 plates, mags. 11·0, 11·1, 10·9. Var. ? M.
(10)	31·4914	23 21 6·6	31 55·6	9·3	See note. E.
	31·4916	23 21 14·9	31 55·5	9·3	
(11)	28·4599	23 26 14·2	28 45·2	9·5	Oct. 18. Not seen. There is a 9·5 mag. $1^m \pm$P.M.
(12)	27·4608	23 36 42·2	27 42·0	9·5	Dec. 18. 11·0 mag. M.

Note.

No. 10, Dec. 18. Only one star here. A time transit gave $0^m\ 59^s{\cdot}4f.$ + 31°·4910, or $23^h\ 21^m\ 11^s{\cdot}5$ for 1855. This agrees with neither star. In Arg., **6**, 172, there are four observations of B.D. + 31°·4914 and the mean place is $23^h\ 21^m\ 11^s{\cdot}65$ + 31° 55′·5. The Uccle Chart + 31°·156 shows only one star.

New Double Stars.

Espin No.	B.D.	1900. R.A.	1900. Decl.	P.	D.	Mags.		Nts.	Date 1926.
	°	h m	° ′	°	″				
2210	..	0 12·1	+32 59	267·8	3·14	9·5	9·6	2	·832
2211	..	1 19·8	33 22	224·2	2·93	10·0	12·0	2	·908
2212	+33·237	22·9	33 32	179·2	6·06	9·2	12·5	2	·011
2213	..	41·7	33 53	207·5	2·19	10·0	10·2	3	·050
2214	+38·985	4 51·4	38 34	37·1	6·37	9·1	13·0	3	·141
2215	..	51·7	38 44	354·8	2·26	9·7	10·5	3	·082
2216	+38·1194	5 24·7	38 38	122·7	3·10	9·5	9·7	3	·167
2217	+38·1257	35·5	38 28	125·4	3·73	9·3	9·5	2	·119
2218	+38·1404	6 4·8	38 57	34·8	2·48	9·3	12·0	3	·162
2219	+39·1618	18·6	39 8	278·2	9·67	9·5	9·5	2	·194
2220	+38·1512	24·9	38 57	13·3	4·29	9·5	9·6	2	·202
2221	..	9 20·2	34 19	249·9	4·73	11·0	11·0	2	·279
2222	+33·1980	10 18·8	33 29	288·3	7·87	9·2	10·5	1	·282
2223	+34·2173	47·9	34 10	199·5	3·43	9·5	13·7	4	·273
2224	+35·2313	12 1·9	34 54	34·8	1·85	9·0	12·0	2	·279
2225	+39·3025	16 37·3	39 51	136·7	2·48	9·5	11·2	3	·574
2226	+39·3028	38·8	39 18	277·5	4·49	9·3	9·8	2	·557
2227	+36·2859	17 18·7	36 13	355·3	4·97	9·5	9·5	2	·579
2228	+35·2975	22·6	35 51	31·1	4·61	9·4	9·5	3	·606

Espin No.	B.D.	1900. R.A.	1900. Decl.	P.	D.	Mags.	Nts.	Date 1926.
	°	h m	° ′	°	″			
2229	+36·2885	17 28·1	+36 5	38·2	4·14	9·3 12·0	2	·583
2230	+36·2887	28·2	36 8	90·2	8·61	9·3 9·5	2	·583
2231	+34·3173	18 14·1	34 53	270·2	7·45	9·0 10·5	3	·640
2232	..	19·8	34 46	191·3	2·85	9·5 11·5	4	·619
2233	+33·3241	48·6	33 14	83·2	2·27	11·5 11·7	2	·710 BC
				123·0	7·12	D = 13·5	2	·710 BD
				246·6	44·86	A = 8·5	1	·709 AB
2234	+32·3251	50·9	33 3	305·3	6·22	9·5 10·5	2	·751
2235	..	53·9	34 45	166·1	2·41	10·1 10·6	2	·606
2236	+34·3387	56·6	34 39	177·8	6·95	9·0 13·0	2	·638
2237	+33·3314	19 1·0	33 25	42·9	9·25	9·1 9·2	2	·821
2238	..	10·1	34 44	216·3	3·43	10·2 10·5	4	·739
2239	+34·3477	11·1	34 56	52·8	5·81	9·5 12·0	3	·759
2240	+34·3577	25·9	34 41	143·5	2·62	12·0 12·5	2	·791 BC
				346·8	11·70	A = 9·2	2	·791 AB
2241	+34·3582	27·3	34 54	30·5	3·10	11·5 11·8	2	·723 BC
				350·3	9·16	D = 13·0	3	·737 BD
				301·0	28·05	A = 9·5	2	·723 AB
2242	+34·3656	35·6	34 27	353·7	2·04	9·3 12·7	3	·827
2243	..	38·4	34 37	218·3	3·52	10·5 11·5	2	·784
2244	+35·3804	44·0	35 16	25·4	3·39	9·6 12·5	5	·675
2245	+35·3808	44·1	35 18	64·6	4·12	9·6 12·5	3	·659
2246	+35·3834	47·5	35 36	239·6	6·55	9·0 13·0	3	·683
2247	+35·3905	55·9	35 27	269·0	4·39	9·2 13·0	3	·708
2248	+35·3969	20 3·5	35 17	34·0	7·79	9·0 13·7	2	·700
2249	..	12·5	35 14	171·2	4·29	10·0 11·5	2	·701
2250	+34·4089	31·4	35 4	123·3	5·74	9·3 12·0	2	·894
2251	+35·4191	33·4	35 20	192·0	4·04	9·5 12·0	2	·650
2252	+35·4258	42·3	35 11	295·4	3·96	8·5 11·0	2	·653
2253	..	44·5	47 32	334·6	3·75	10·0 10·2	1	·704
2254	+35·4405	21 3·6	35 22	275·9	8·08	9·1 9·3	2	·729
2255	+34·4292	4·1	34 25	249·2	4·29	9·5 10·5	2	·894
2256	+34·4308	5·6	34 12	128·0	5·70	8·5 13·0	2	·908
2257	+34·4311	5·7	34 40	271·2	4·19	9·9 12·0	4	·895 BC
				261·4	16·71	A = 9·5	2	·882 AB
2258	+34·4341	9·9	34 39	172·6	3·22	9·2 12·0	3	·853

Espin No.	B.D.	1900. R.A.	1900. Decl.	P.	D.	Mags.	Nts.	Date 1926.
	°	h m	° ′	°	″			
2259	+34·4369	21 17·9	+34 59	241·7	4·37	10·0 12·0	2	·650
2260*	+32·4159	22·3	32 49	63·3	1·58	9·7 12·0	2	·730 BC
	h 935 ?	..	..	23·3	14·58	A = 9·5	3	·724 AB
2261	..	22·5	33 47	139·6	3·95	9·8 10·5	2	·715
2262*	..	22·9	33 53	70±	1·3±	9·5 11·0	2	·907
2263	+33·4272	24·9	33 31	30·1	3·43	9·7 12·0	2	·782
2264	+32·4255	42·5	33 0	281·2	7·70	9·3 12·0	3	·789
2265	..	44·9	32 26	23·3	3·20	9·6 10·0	2	·940
2266	+32·4270	45·4	32 53	108·0	5·89	9·4 10·0	2	·793
2267	+32·4382	22 13·0	33 8	223·9	2·62	9·5 11·0	2	·676
2268	+32·4427	22·3	32 15	262·3	5·85	9·3 10·0	2	·793
2269	..	27·0	32 4	61·2	4·00	9·7 13·0	2	·928
2270	..	30·8	32 29	159·9	3·20	9·6 12·0	3	·763
2271	+32·4503	39·9	32 31	205·4	2·02	9·5 9·5	2	·777
2272	..	44·5	32 38	20·1	2·14	9·5 9·6	2	·777
2273	..	23 30·8	33 52	319·4	4·51	9·6 12·0	3	·863 (1925)

Notes.

2260. *h* notes that the two observations differ in Decl. by 1°. *β* failed to find the double. The wide pair agrees well with *h*'s place, allowing for the error of 1°.

2262. I was unable to be sure that this star is really double.

M. No.	B.D.	1900. R.A.	1900. Decl.	P.	D.	Mags.	Nts.	Date 1926.
	°	h m	° ′	°	″			
441	+29·15	0 6·3	+29 15	0·0	14·61	9·0 9·1	2	·757 AB
				351·4	38·46	C = 10·0	2	·757 BC
				141·1	5·28	D = 11·5	3	·784 CD
442	+31·80	30·8	32 9	103·7	8·27	9·0 10·0	2	·960
443	..	50·8	28 55	195·9	3·70	9·5 10·4	4	·871
444	..	1 0·2	32 32	83·8	6·20	9·5 10·0	3	·962
445	..	16·9	29 18	4·5	5·59	9·7 11·7	2	·995
446*	+28·258	29·2	29 5	215·4	5·25	9·0 10·2	2	·943
447	+63·234	38·8	63 41	123·0	2·68	9·7 10·1	2	·015
448	+28·307	44·7	29 12	295·6	2·37	9·4 11·0	1	·999
449*	..	45·1	64 13	327·5	2·91	9·5 12·5	3	·049
450*	..	56·1	32 55	150·7	4·56	10·3 10·4	2	·995

M. No.	B.D.	1900. R.A. h m	Decl. ° ′	P. °	D. ″	Mags.		Nts.	Date 1926.	
451	..	1 56·9	+32 44	77·4	7·24	9·7	10·0	2	·999	
452	..	2 2·3	27 44	154·9	3·41	10·0	12·0	2	·971	
453	+33·407	14·2	33 38	275·0	7·73	9·5	9·7	2	·999	
454	..	38·5	28 31	232·7	3·98	10·0	10·0	2	·958	
455*	..	43·7	64 24	293·1	3·48	9·5	12·2	2	·082	
456	+29·509	55·3	29 17	21·5	4·09	9·5	14·0	3	·974	
457	..	6 23·1	67 16	289·3	2·75	10·4	10·9	2	·119	
458	..	53·0	67 58	143·8	2·49	11·0	12·0	2	·167	
459	..	8 6·9	69 36	251·1	3·68	10·0	10·5	2	·203	
460	+69·481	31·8	69 46	231·0	3·25	9·5	9·6	2	·203	
461	..	10 17·4	68 9	248·8	5·62	9·5	9·9	3	·264	
462	..	37·5	68 28	319·6	2·72	9·5	9·6	3	·276	
463	..	11 33·5	61 10	338·6	2·72	10·0	11·0	3	·264	
464	+61·1296	12 23·2	61 37	335·9	4·37	9·3	9·7	1	·279	
465	..	26·1	64 37	155·5	2·45	9·5	11·7	3	·270	
466	+28·3050	18 36·4	28 40	355·2	40·61	9·3	10·5	1	·586	AB
				305·0	4·17	C = 11·5		3	·599	BC
467	+28·3116	50·3	28 48	198·9	7·89	9·0	10·7	3	·581	
468	+28·3199	19 3·3	28 55	182·9	7·74	9·2	9·8	3	·640	
469	..	18·7	29 2	281·7	4·67	11·0	11·3	3	·581	
470	+28·3312	19·2	28 30	206·1	7·81	8·8	12·0	2	·650	
471	+27·3377	20·0	28 3	42·6	9·75	9·1	10·7	3	·684	
472	+28·3330	22·0	28 18	355·3	9·77	9·4	9·8	2	·723	
473	..	22·6	28 14	161·6	3·29	10·5	11·7	2	·713	
474	..	39·4	28 54	337·3	3·29	9·5	11·2	2	·676	
475	..	48·6	28 30	292·8	2·63	10·2	13·7	4	·639	
476	+28·3531	51·6	28 23	87·5	5·29	9·0	10·7	2	·706	
477*	..	20 6·3	29 2	80·9	4·19	9·8	10·2	3	·774	
478*	..	11·9	29 11	16·2	6·13	9·5	10·0	3	·719	
479	+28·3746	22·0	28 50	154·8	5·40	9·2	11·0	2	·634	
480	..	22·8	40 9	94·5	9·08	9·5	9·6	2	·812	E
481	..	29·8	29 2	325·3	4·48	9·5	11·0	2	·645	
482	+27·3810	32·6	28 1	266·9	6·33	9·5	13·0	3	·806	
483	+28·3817	33·2	28 26	69·7	6·70	9·5	10·3	2	·784	
484	+28·3910	48·1	28 16	85·9	7·69	8·7	9·4	3	·840	
485	..	52·1	28 46	181·8	5·59	10·0	10·0	2	·653	

M. No.	B.D.	1900. R.A.	1900. Decl.	P.	D.	Mags.	Nts.	Date 1926.
	°	h m	° ′	°	″			
486	..	20 56·5	+28 19	347·2	4·10	9·1 9·2	2	·690
487	..	21 4·5	28 52	154·8	3·55	9·5 11·7	3	·759
488	+28·4034	11·2	28 23	316·3	8·63	9·5 11·5	3	·840
489	+28·4045	13·3	28 16	203·0	4·91	9·3 11·3	3	·871 AB
				282·3	9·42	C = 11·0	2	·868 AC
490	..	31·8	28 50	313·3	3·25	9·4 9·5	2	·690
491	..	34·0	29 26	62·0	3·21	11·0 12·0	4	·857
492	..	37·4	28 34	132·6	5·90	9·5 11·5	1	·920
493	+29·4495	39·8	29 14	351·9	7·85	9·5 10·0	2	·663
494	..	48·5	29 11	354·8	4·09	9·4 9·6	2	·882
495	..	49·3	28 28	140·7	4·59	10·2 10·3	2	·650
496	..	55·7	28 38	166·8	3·75	10·0 10·1	2	·690
497	+28·4263	55·8	28 53	186·2	7·39	9·4 10·5	2	·846
498*	+28·4300	22 4·3	28 18	193·0	6·47	9·5 9·7	2	·882 AB
				82·4	10·00	C = 10·0	2	·882 AC
499	+28·4341	13·2	28 21	180·5	4·37	9·5 12·0	2	·798
500	..	21·0	28 54	172·2	4·73	10·0 10·3	3	·872
501	+27·4346	30·2	27 34	87·2	7·27	9·0 12·0	2	·945
502	..	46·0	28 21	105·8	4·98	9·5 10·0	2	·777
503	..	23 6·3	27 26	159·6	7·24	9·7 9·8	2	·964
504	..	9·8	28 58	159·4	4·86	9·5 11·7	2	·690
505	+39·5056	14·0	39 41	141·2	8·76	8·6 11·0	2	·865 E
506	+27·4586	33·5	28 12	233·4	6·74	9·5 10·0	2	·894
507	+27·4590	34·8	28 2	192·4	6·28	9·4 10·5	3	·840
508	+33·4809	54·3	33 35	356·9	7·73	9·1 10·1	2	·968
509	+27·4668	57·8	28 11	324·3	3·48	9·5 11·0	2	·960
510	+28·4694	58·0	28 56	142·9	5·31	9·5 12·0	3	·840

Notes.

446. A star, mag. 9·0, at P. 32°, D. 60″±.
449. Not given in B.D., but No. 1636, mag. 9·4, in A.G. (Camb.).
450. A star, mag. 9·7, at P. 205°±, D. 25″±.
455. On several nights A was suspected of being a close double.
477. B.D. + 28°·3646, mag. 7·5, at P. 26°·4, D. 139″±.
478. B.D. + 29°·3962, mag. 9·4, at P. 79°·7, D. 180″±.
498. B.D. declination seems to require a correction of + 3′·6. Nos. 480 and 505 were transferred from list in *M.N.*, **78**, No. 3, on remeasurement.

Faint Stars in the Selected Areas with large Proper Motion. Second List from the Radcliffe Observatory, Oxford. By H. Knox-Shaw, M.A., D.Sc., Radcliffe Observer.

It has been decided to publish periodically lists of stars in the Selected Areas, which are found to have proper motions as large as 0″·1 per annum. This is the second such list, the first having been published in *M.N.*, **86**, 342. It contains seventeen stars found in eleven areas. For further explanation reference should be made to the paper just quoted.

Faint Stars in the Selected Areas with large Proper Motion.

Selected Area No.	Area measured.	No. of Stars measured.	No. of Comparison Stars.	Mean Mag. of Comparison Stars.	Limiting Magnitude.	Star No.	Magnitude.	R.A. 1900·0.	Dec. 1900·0.	Annual Proper Motion. μ_α.	μ_δ.	μ.
								h m s	° ′	″	″	″
1	50′×50′	239	89	13·5	15·7	196	12·3	6 36 6	+89 1′·6	−0·048	−0·096	0·107
						130	14·8	6 50 0	+88 49·8	+ ·054	+ ·146	·156
5	60×60	248	117	12·8	15·0	299	9·2	12 28 6	+75 2·6	− ·148	− ·005	·148
7	50×50	379	152	13·3	15·2	944	14·3	20 19 18	+75 34·8	− ·100	− ·254	·273
						598	13·7	20 22 18	+75 18·4	+ ·035	+ ·117	·122
						431	12·4	20 23 42	+75 6·4	+ ·100	+ ·172	·199
						434	9·7	20 24 18	+75 7·4	− ·016	+ ·102	·103
8	40×40	761	282	13·2	15·2	—	14·4	0 57 58	+60 32·9	+ ·106	·000	·106
10	40×40	203	100	13·2	15·1	136	7·1	5 8 33	+60 4·3	+ ·026	− ·103	·106
						336	13·8	5 9 32	+60 23·6	− ·007	− ·115	·115
						342	15·0	5 9 44	+60 23·9	+ ·184	− ·465	·500
12	60×60	183	118	13·3	14·9	199	7·9	9 2 9	+59 33·5	− ·166	+ ·042	·171
						216	10·3	9 4 16	+59 31·8	− ·086	− ·165	·186
						371	12·6	9 6 18	+60 6·2	− ·053	− ·150	·159
14	60×60	237	98	13·4	15·4	175	14·5	13 25 55	+59 22·9	+ ·067	− ·088	·111
16	50×50	227	120	12·9	15·1	—						
18	40×40	568	234	13·5	15·7	171	11·4	21 24 27	+59 54·1	+ ·090	+ ·073	·116
67	50×50	311	167	13·3	15·1	—						
105	60×60	146	72	13·1	14·8	214	7·3	13 31 8	− 0 25·1	− ·178	− ·101	·205

Occultations of Stars by the Moon in the years 1925, 1926, *observed at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

Date and Greenwich Time of Observation.	Star.	Mag.	Phase.	Moon's Limb.	Observer.	Aperture.
d h m s						in.
1925 Jan. 4 22 13 47·57	B.D.+11° 445	6·8	Dis.	Dark	A.C. (1)	3·7
6 16 3 45·94	Aldebaran	1·1	Re.	Bright	A.C.	6·7
6 16 3 46·29	,,	1·1	,,	,,	P.M.	10
Feb. 1 19 25 25·12	B.D.+13° 579	6·9	Dis.	Dark	A.C. (2)	6·7
2 18 57 27·12	75 Tauri	5·2	,,	,,	J.J.	28
2 18 57 27·37	,,	5·2	,,	,,	P.M. (3)	10
2 18 57 28·02	,,	5·2	,,	,,	L.S.	6·7
2 19 27 40·65	W.B. (2) IV. 450	6·6	,,	,,	J.J. (4)	28
2 19 27 39·65	,,	6·6	,,	,,	H.C.	6·5
2 19 27 40·41	,,	6·6	,,	,,	P.M. (5)	13
2 19 27 40·91	,,	6·6	,,	,,	F.J.	10
2 23 54 25·54	Aldebaran	1·1	,,	,,	J.J.	28
2 23 54 25·07	,,	1·1	,,	,,	A.C. (6)	6·7
2 23 54 25·23	,,	1·1	,,	,,	P.M.	13
2 23 54 25·63	,,	1·1	,,	,,	F.J.	10
2 23 54 25·63	,,	1·1	,,	,,	L.S.	6·5
2 23 54 25·95	,,	1·1	,,	,,	G.R.	3
3 0 46 3·40	,,	1·1	Re.	Bright	A.C. (3)	6·7
3 0 46 4·21	,,	1·1	,,	,,	G.R.	3
28 20 23 6·45	Lalande 6268	6·2	Dis.	Dark	A.C. (7)	6·7
28 20 23 7·12	,,	6·2	,,	,,	F.J.	3·7
1926 Jan. 20 21 10 50·27	Piazzi I. 225	7·1	,,	,,	L.S. (8)	6·7
June 12 20 49 52·12	63 Geminorum	5·3	,,	,,	A.C. (9)	3·7
Sept. 12 19 52 31·62	o^2 Libræ	6·7	,,	,,	A.C. (7)	3·7
18 18 48 36·00	105 B Capricorni	6·6	,,	,,	A.C. (1)	6·7
18 20 17 1·07	26 Capricorni	6·8	,,	,,	A.C. (1)	6·7
19 22 29 54·89	Lalande 43363	6·6	,,	,,	A.C. (10)	6·7
26 21 49 31·46	Piazzi IV. 179	6·1	Re.	,,	A.C.	3·7

The initials J.J., A.C., P.M., F.J., L.S., G.R., H.C., are those of Dr. Jackson, Dr. Crommelin, Mr. Melotte, Mr. Jeffries, Mr. Symms, Mr. Rickett, Mr. Cox.

The instruments are :—28 inch, the 28-inch equatorial; 13 inch and 10 inch, the Astrographic equatorial and its guiding telescope; 6·7 inch, the Sheepshanks equatorial; 6·5 inch, the Corbett equatorial; 3·7 inch and 3 inch, portable telescopes in the altazimuth and 28-inch domes.

Notes.

(1) Sky very clear; star held steadily till disappearance.
(2) Earth-shine faintly visible.
(3) Sudden.
(4) Possibly a double star; disappeared in two stages 1 sec. apart. The time given is for second (brighter) component.
(5) Disappeared slowly.
(6) Thin cloud, but star could be held steadily.
(7) Sky very clear; earth-shine plainly visible.
(8) Disappearance gradual; star faint.
(9) Bright twilight; star faint; observation difficult.
(10) Star very faint at disappearance; observation difficult.

Royal Observatory, Greenwich:
1927 *January* 14.

Occultations of Stars by the Moon, observed at the Astronomical Observatory, Kiew, in the year 1926. By Professor S. D. Tscherny.

(*Communicated by the Secretaries.*)

No.	Date 1926.	G.M.T. h	m	s	Star.	Mag.	Dis. or Reap.	Telescope and Power.	Observer.
1	Jan. 23	16	18	30·29	63 Tauri	5·7	D	R 145	T
2	23	16	18	30·23	63 Tauri	5·7	D	B 61	L
3	Apr. 15	18	34	52·26	δ Tauri	3·9	R	R 145	T
4	15	18	57	51·49	W.B. (2) IV. 381 *	7·9	D	R 145	T
5	15	19	2	53·16	64 Tauri	4·9	R	R 145	T
6	16	18	34	23·65	351 B Tauri	10·0	D	R 224	T
7	16	18	34	42·62	351 B Tauri	6·2	D	R 224	T
8	16	18	34	42·91	351 B Tauri	6·2	D	K 24	D
9	16	19	22	44·73	353 B Tauri	6·5	D	R 224	T
10	16	20	3	33·03	353 B Tauri	6·5	R	R 145	T
11	18	20	15	17·06	120 B Geminorum	6·5	D	R 145	T
12	18	20	15	17·04	120 B Geminorum	6·5	D	K 24	D
13	20	18	56	24·23	139 B Cancri	6·1	D	R 145	T
14	20	18	56	25·52	139 B Cancri	6·1	D	K 24	D
15	26	21	17	23·01	80 Virginis	5·2	D	R 145	T
16	May 15	20	26	8·30	*d* Geminorum	5·2	D	R 145	T
17	15	20	26	8·43	*d* Geminorum	5·2	D	B 61	L
18	15	20	26	8·29	*d* Geminorum	5·2	D	K 24	D
19	July 23	21	3	43·61	154 B Sagittarii	5·9	D	R 145	T
20	24	21	44	42·56	329 B Sagittarii	6·1	D	R 145	T
21	25	21	24	17·59	η Capricorni	4·8	D	R 145	T
22	25	22	2	55·24	η Capricorni	4·8	R	R 145	T
23	Sept. 26	21	8	12·06	302 B Tauri	6·1	D	R 145	T

No.	Date 1926.	G.M.T. h m s	Star.	Mag.	Dis. or Reap.	Telescope and Power.	Observer.
24	Sept. 26	21 34 45·70	302 B Tauri	6·1	R	R 145	T
25	27	19 46 56·26	ζ Tauri	3·0	D	G 58	P
26	27	19 46 55·76	ζ Tauri	3·0	D	U 74	F
27	27	20 1 37·22	ζ Tauri	3·0	R	R 145	T
28	27	20 1 37·64	ζ Tauri	3·0	R	G 58	P
29	27	20 1 37·64	ζ Tauri	3·0	R	U 74	F
30	Oct. 14	16 41 35·91	53 Sagittarii	6·3	D	R 145	T
31	14	16 41 35·52	53 Sagittarii	6·3	D	B 61	L
32	14	16 51 34·47	274 B Sagittarii	6·1	D	R 145	T
33	14	16 51 34·93	274 B Sagittarii	6·1	D	B 61	L
34	Nov. 15	14 29 1·00	33 Piscium	4·7	D	R 145	T
35	15	14 29 2·31	33 Piscium	4·7	D	B 61	L
36	15	15 5 29·51	33 Piscium	4·7	R	R 145	T
37	15	16 57 22·46	24 B Ceti	6·0	D	R 145	T
38	15	16 57 22·44	24 B Ceti	6·0	D	B 61	L
39	15	18 7 32·93	24 B Ceti	6·0	R	R 145	T

Instruments used :—

R = 243-mm. Merz-Repsold refractor.
K = 120-mm. Utzschneider and Fraunhofer comet-seeker.
B = 81-mm. Busch refractor.
U = 72-mm. Utzschneider and Fraunhofer refractor.
G = 70-mm. Goerz refractor.

Observers :—

T = S. Tscherny.
D = M. Ditschenko.
P = N. Pisarenko.
F = O. Fialkowskaja.
L = E. Laurentjewa.

Notes.

Nos. 3, 4, 7, 9, 11, 15, 16, 19, 24, 27 : instantaneous.
Nos. 1, 13, 32, 34, 37, 39 : good.
Nos. 5, 6, 10, 20, 22, 23, 30, 35, 36, 38 : satisfactory.
No. 21 : doubtful ; observed through clouds.
Nos. 31, 33 : windy.

Note by the Secretaries.

No. 4 was described by the author as Anonyma, mag. 8·6. It has been identified by the Secretaries. The position for 1926·0 is $4^h\ 21^m\ 37^s{\cdot}55$, $+\ 17^\circ\ 16'\ 46''{\cdot}3$ (from Abbadia, 6 observations 1905, with P.M. $+\ 0^s{\cdot}0033$, $-\ 0''{\cdot}03$). In reporting the occultations of unidentified stars the approximate position angle should be given.

Astronomical Observatory, Kiew :
1926 *December* 19.

Annual Report for 1926 *of the Joint Permanent Eclipse Committee.*

The Committee have met twice in the year to receive the report of the expedition sent to Sumatra to observe the total solar eclipse of 1926 January 14 and to make preliminary arrangements for the total eclipse of 1927 June 29, visible in this country and in Scandinavia.

With regard to the eclipse of 1926, the Committee report with pleasure that the expedition was favoured with fine weather and secured many valuable photographs and spectrograms. A preliminary report on the results obtained was made to a joint meeting of the Royal and Royal Astronomical Societies on 1926 November 11, and it is hoped that the final report of the expedition will shortly be published in the *Memoirs* of the Royal Astronomical Society.

By way of preparation for the eclipse of 1927, the Committee, with the consent of the Council of the Royal Society, entrusted Messrs. Sir Howard Grubb, Parsons & Co., with some very necessary repairs and overhauling of the 16-inch cœlostats in the charge of the Committee. To meet the cost of these repairs the Committee was authorised to sell two of the cœlostats at a charge of about £75 each. The Solar Physics Observatory Fund, Cambridge University and Lord Leigh's Fund, Oxford University, through Professor Newall and Professor Turner respectively, purchased these instruments at £75 each. The instruments have been struck off charge, and the money is at present held by the Secretary.

No official expedition has been arranged by the Committee for the eclipse of 1927, but the Committee are arranging to help, with the loan of apparatus where possible, the following observing parties :—

1. A party from the Royal Observatory at Giggleswick.
2. A party at Hartlepool organised by Dr. Lockyer and Sir F. McClean.
3. A party at Southport organised by Professor Turner and Dr. H. Knox-Shaw.
4. A party at Stonyhurst under Father O'Connor.
5. An expedition to Äl, in Norway, under Professor Newall.

It is hoped that one or two further parties may be organised in the East Riding and possibly in N. Wales.

The Committee report with pleasure that they have received a gift of £50 from Colonel J. Waley Cohen, C.M.G., D.S.O., who accompanied the expedition to Sumatra as a volunteer, the money to be applied primarily to research in photographic dyes and stains, and in particular to their use in tropical climates under eclipse conditions.

Various sub-committees have been appointed to deal with this matter, the allocation of instruments for the 1927 eclipse, publicity, and a short informative pamphlet for amateur and other astronomers.

To the above report the following should be added : Professor Fowler will observe the very large partial eclipse with powerful spectroscopic apparatus at South Kensington, and Professor Sampson will also make special observations of the large partial eclipse at Edinburgh.

Plans for Observing the Total Eclipse of 1927 *June* 29.

At the January meeting of the Society the Chairman asked those Fellows who were proposing to observe the eclipse to speak about their arrangements. The following is a report of what they said :—

Professor Turner.—Southport has sent an invitation to the Eclipse Committee, and, in response to that invitation, I am going with Dr. Knox-Shaw to occupy a station there. I hope to take the astrographic object-glass and a cœlostat, and propose to work on the brightness and polarisation of the corona. I should also like to encourage amateurs in Southport and its neighbourhood ; and whilst I would urge that anyone not actually an astronomer should make it his primary business to *see* the eclipse, I think that amateurs may do useful work by timing the contacts, as it will be possible to get time accurately from wireless signals.

Professor Newall.—From the Solar Physics Observatory at Cambridge we hope to send an expedition to Norway, where the sun will be at an altitude of over 20°. We propose to undertake a study of the chromosphere, working in the infra-red. Dr. Carroll and I went over in September last and chose our site. The party will consist of Dr. Carroll, Mr. Stratton, Mr. Butler, Mr. Bryan (of America), and Dr. Smart, in addition to Mrs. Newall and myself. We propose attempting the observation of the chromosphere in the way Professor A. Fowler and I have used for partial eclipses, and we hope to get information about the calcium lines in the infra-red. In addition, we propose to attempt observations in the ultra-violet, interferometer, and polariscope work on the corona, as well as direct photography of the latter.

Professor Fowler.—My main objective at the forthcoming eclipse is to examine the flash spectrum under high resolving power and dispersion. On the central line the flash spectrum is presented for only two or three seconds at the second and third contacts, and the exposure possible is thus so short that instruments of large dispersion cannot be effectively employed. Evershed in 1900 showed how, by going to the edge of the shadow zone, the time available for the investigation of the flash spectrum could be considerably extended ; and Professor Newall at Cambridge and I at South Kensington in 1912 observed the flash during an eclipse of magnitude 0·92 by working at the cusps, and found that the period then available was nearly half an hour. The slide on the screen shows the principle of this method, which takes advantage of the fact that the chromosphere and flash strata project at the cusps to a distance much greater than their vertical depths. The coming eclipse will be particularly favourable for this method, on account of the near equality of the apparent diameters of the Sun and Moon, and I shall stay at South Kensington and work there with a large grating spectrograph. The magnitude of the eclipse will be 0·96, and even if the sky be hazy we can still carry out the other part of my programme, which is to study the spectrum of the Sun's disc near the limb. During an eclipse there is no light from the

rest of the disc scattered by our atmosphere and so superposed upon the light from the limb.

Colonel Stratton.—It may be of interest to Fellows to hear something of the plans of some other expeditions, of which some details have reached me. Dr. Lockyer and Sir Francis McClean are going to Hartlepool, taking the transparent Thorpe grating for direct image and first-order spectrum of the corona. Father O'Connor and Mr. Gibbs at Stonyhurst will try to secure direct photographs of the corona with a lens of 19 ft. focal length, and also the flash spectrum at the cusps with the Hilger slit-spectrograph and the Thorpe prismatic camera. An expedition to North Wales is being planned by some students at the Cavendish Laboratory, and there is, I understand from Mr. Gregory, to be an expedition from University College, London.

Other Scandinavian expeditions are those of Professor S. A. Mitchell from the Leander McCormick Observatory, and of Dr. Stetson from Harvard. Dr. Rosseland will use some of Dr. Anderson's apparatus, which was taken to Sumatra for last year's eclipse, but owing to bad weather was not fully used. There will also be a Dutch party farther north, who will be engaged upon spectrophotometric work. In addition, one may assume that the Scandinavian astronomers will be active in their own countries.

The Chairman (Sir Frank Dyson).—I will say a few words about the Greenwich programme: We propose sending a party to Giggleswick, where a site has been kindly offered by the headmaster of Giggleswick School. The members of the party will be Dr. Jackson and Messrs. Davidson, Melotte, and Woodman. They will take amongst other apparatus a 6-inch lens of 45 feet focus lent by Mr. Worthington. The programme will include photography of the chromospheric spectrum, with a view to comparing the intensities of the H and K lines with the calcium lines in the infra-red. Direct photographs of the corona will also be taken.

Mr. Evershed.—I would like to urge upon spectroscopic observers the importance of going to a site where good definition may be expected. I have found that definition of the Sun is always better at sea than it is over land, and so a site from which the Sun will be seen at the time of the eclipse over water is to be preferred. A hill-top is especially to be avoided.

The Rev. T. E. R. Phillips.—I think I would suggest that amateur observers use the opportunity to enjoy the magnificent spectacle provided, and especially to note the imposing onrush of the Moon's shadow, and that they leave the detailed and complicated investigations to those institutions best equipped and provided for them.

Erratum.

P. 109, last line of footnote, *for* No. 44 is an error *read* No. 43 is an error.